PRACTICAL WOOD PATTERN-MAKING

J. Robert Hall

Practical Wood Patternmaking

by

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WARNING

Remember that the materials and methods described here are from another era. Workers were less safety conscious then, and some methods may be downright dangerous. Be careful! Use good solid judgement in your work, and think ahead. Lindsay Publications Inc. has not tested these methods and materials and does not endorse them. Our job is merely to pass along to you information from another era. Safety is your responsibility.

Preface

Patternmaking has been growing in importance through the centuries. Today, in an era of machine production dependent on expert tooling, the patternmaker has assumed more importance than ever before. There is a constant demand for skilled men, for all new creations of the inventors and scientists working with metals are dependent on the patternmaker for the completion of their machines.

The purpose of this textbook is to prepare the individual to become a skilled patternmaker in the shortest possible time. It is designed for use in vocational or technical schools and in apprenticeship training. The instructions proceed step by step from blueprint reading to simple patterns and to the more complicated ones. Many blueprints have been included to provide ample practice material. The material is grouped into divisions, each of which covers some phase of patternmaking. Numerous illustrations and drawings help to simplify the work. Furthermore, initiative is developed by the illustrations, drawings, and blueprints, which permit the student to proceed independently.

Patternmaking is a skilled trade that pays good returns to those who have attained proficiency. This book contains the information with which a patternmaker must be familiar in order to hold a position dependent on his skill. Thirty years of experience as a patternmaker have made it possible for the author to evaluate the principles and practices which form the basis for successful work in the trade.

For illustrations used in the book the author is indebted to Richard Berk, the Modern Pattern Co., the Rex Iron Foundry Co., the Quality Iron Foundry, the Capitol Brass Foundry, all of Los Angeles.

J. Robert Hall.

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Contents

Foreword

It is with a great deal of pleasure and enthusiasm that I am writing a few words of commendation of this text on wood patternmaking. Having watched Mr. Hall in his shop, both in industry and in school, I know of his thoroughness in training apprentices and students to become patternmakers. Observing him gives one the assurance that here is a man who will train a craftsman in the best and most effective methods, in the quickest possible time, and still not omit the related qualities that make an all-round craftsman.

Most textbooks in patternmaking have too many words and too few discussions, outlines for demonstration, and actual practical applications. This book, I believe, provides that practical training experience so necessary to competent performance.

I wish to call particular attention to the organization. The beginner is led through a brief acquaintanceship with bluperint reading on to general information, such as the terminology and nomenclature used on blueprints and patterns, and is given an understanding of the use of these. From here he is led to the simplest fundamental projects in patternmaking, being given the related work and information necessary in constructing these; on to the next more difficult; and, finally, to some rather complicated and difficult patterns, in which the learner himself must begin to estimate the time and materials required for their construction.

The book contains another special feature in the excellent illustrations and photographs of the various types of operations necessary to do patternmaking and molding, presented where they are of the most value. A person interested in patternmaking should find this book very interesting and of much value. It is presented in such simple language and follows such a logical order that a beginner could learn much about patternmaking without help from an instructor.

I recommend this book to instructors of classes in apprenticeship, trade extension, and trade preparatory work.

David F. Jackey,
Professor of Vocational Education
University of California at Los Angeles;
Supervisor of Trade and Industrial Teacher Training.
California State Department of Education.

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PRACTICAL WOOD PATTERNMAKING

1. GENERAL INFORMATION FOR PATTERNMAKERS

Patterns are made for the sole purpose of obtaining a desired shape in a casting. Wood patterns are made for any metal part which is to be cast. The casting is done in a foundry, which is a place where molten metal is cast in *sand* molds that were shaped by the use of a pattern. There are usually three kinds of foundries: steel, cast iron, and brass and aluminum. The last two are poured in the same foundry.

Most patterns are made of wood. There are a few exceptions in the larger class of pattern work, such as those made of plaster and some made of wax for ornamental iron pattern work. All complicated patterns with any coring or delicate work are left to the wood pattern worker.

Wood patterns are made for every kind of machine known, from small patterns ½ in. long to power-plant machinery, large hydraulic presses, and railroad equipment which take thousands of feet of lumber for one pattern: The patternmaker who works on heavy equipment is called a *machine* patternmaker. He is required to have a very good knowledge of blueprint reading, a complete understanding of foundry and core work, and good judgment of the strength of materials. Above all he must have the ability to visualize the shape and form of the pattern from the print so that he can plan its construction after he has studied the drawing, keeping in mind at all times that the pattern will have to be drawn out of the sand by the molder and the cores be placed and fitted to assure the thickness of metal called for by the drawing.

FIG. 1.

The patternmaker should be a master of woodworking tools and machinery and a highly skilled craftsman, because he is required to do exceptionally fine work. Therefore, the beginner must acquire the following fundamentals if he is to become a good mechanic:

1. The proper handling of woodworking tools.
2. A thorough knowledge of molding and core making.
3. The ability to read complicated blueprints.

Without this training a man cannot become a good patternmaker.

FIG. 2.—View of a small gray-iron foundry. Note the vents in the molds for gas to escape.

FIG. 3.—Molder doing small-production work.

2. ORTHOGRAPHIC VIEWS

There is a definite relationship between views on drawings or blueprints. To read blueprints intelligently one must understand this relationship. If certain rules and regulations were not set up and adhered to, drawings could be made by anyone, but no one would know what the draftsman had in mind. As soon as one learns to follow the rules and regulations, he may make drawings that anyone who understands the language of industry can interpret.

See the illustration of the four different views, known as *orthographic* views, of the same block. At least two but usually three and sometimes four views are necessary to describe the pattern clearly enough to make it correctly.

Note that *A* in Fig. 4 has a dotted line and *A* in Fig. 5 has a solid line at the same place. The relationship of one view to the other is the deciding factor on the type of lines used.

Imagine a block in a large bowl, as illustrated. Then this block could be moved up the sides of the bowl at right angles. All lines that can be seen are always shown by a full or solid line. All hidden lines are represented by dotted lines as one looks through the block. By moving this block up as in Fig. 6 the shape on all sides is ascertained.

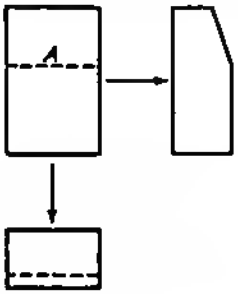


Fig. 4.

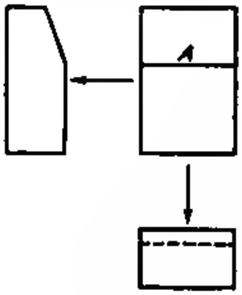


Fig. 5.

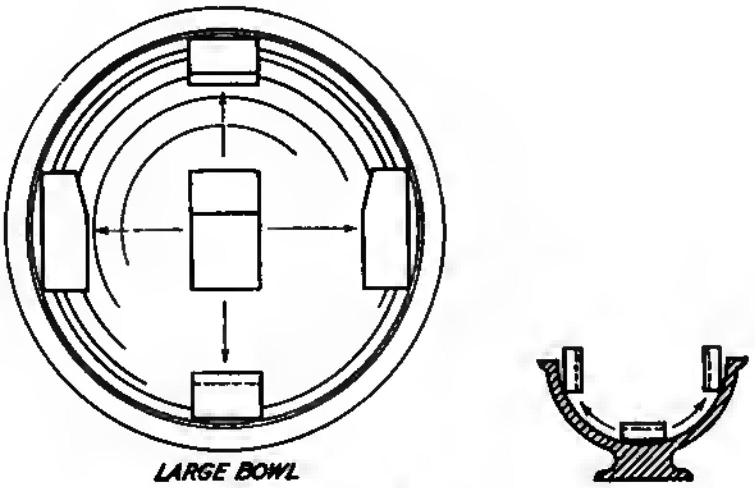
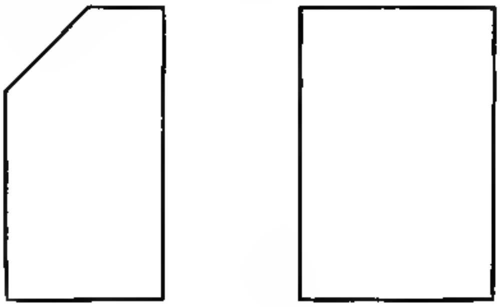


Fig. 6.

3. USE OF ORTHOGRAPHIC PROJECTIONS

Make copies of the following orthographic views, and fill in the missing lines. Do not write in this book.



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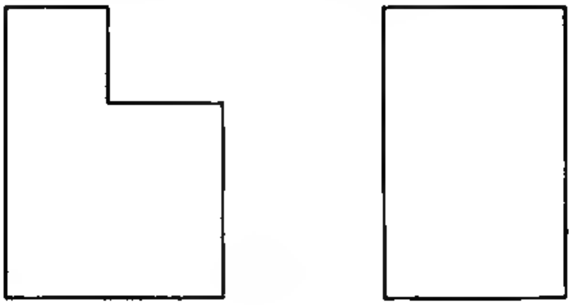


FIG. 8.

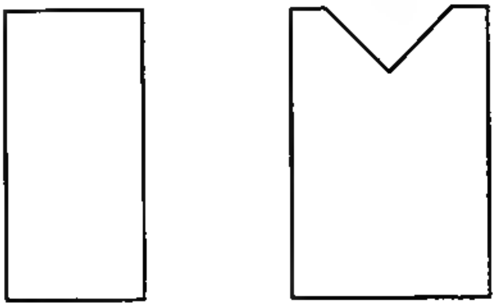


FIG. 9.

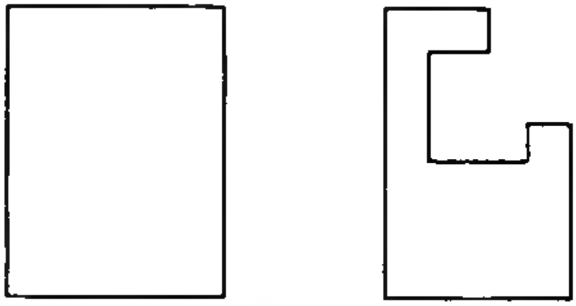


FIG. 10.

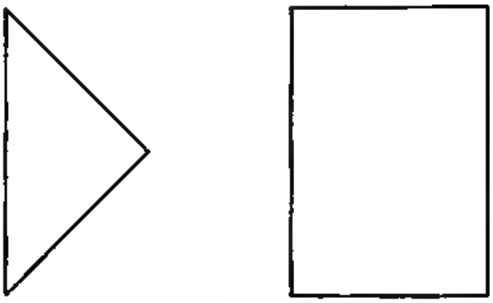


FIG. 11.

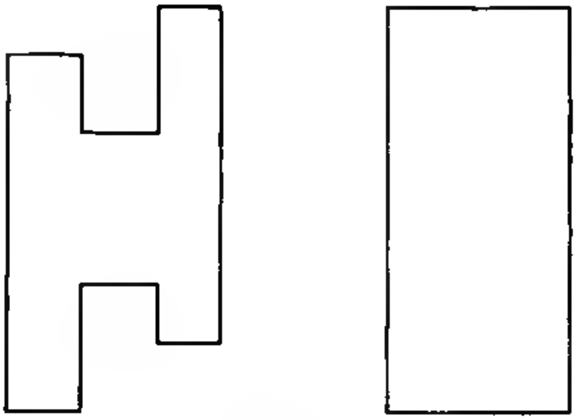


FIG. 12.

Make copies of the following orthographic views, and fill in the missing lines. Do not write in this book.

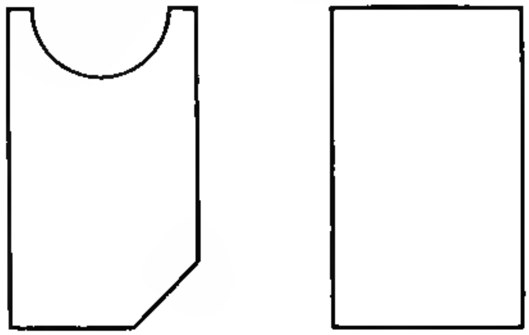


Fig. 13.

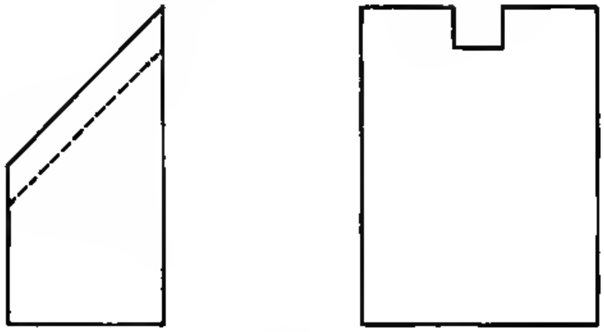


Fig. 14.

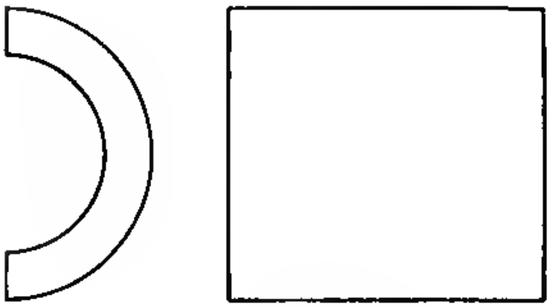


Fig. 15.

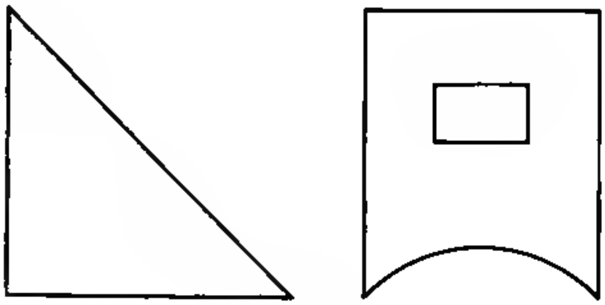


Fig. 16.

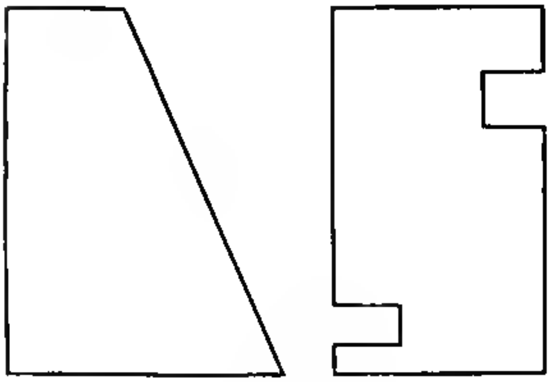


Fig. 17.

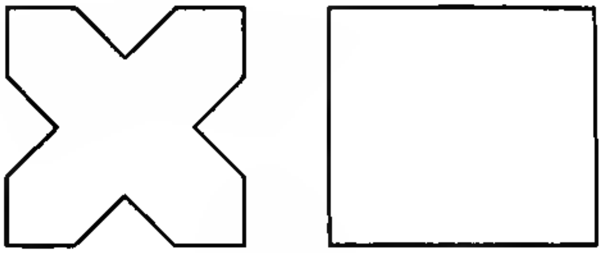


Fig. 18.

Make copies of the following orthographic views, and fill in the missing lines. Do not write in this book.

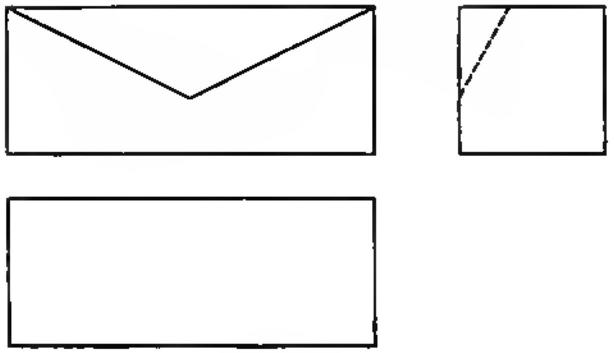
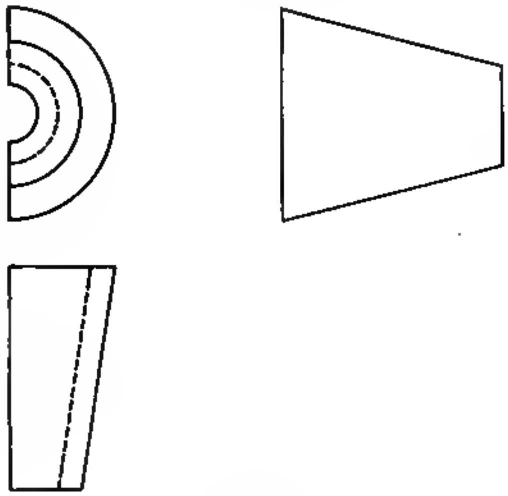


FIG. 19.



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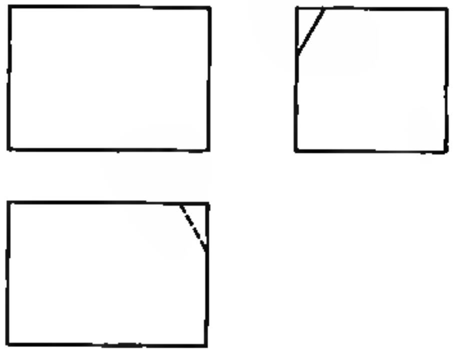

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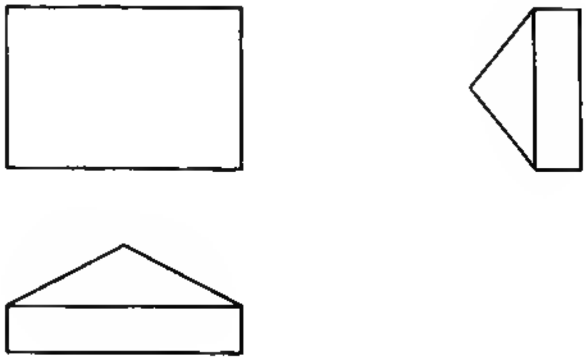

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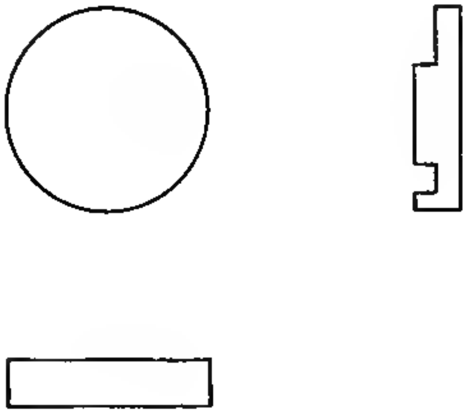


FIG. 23.

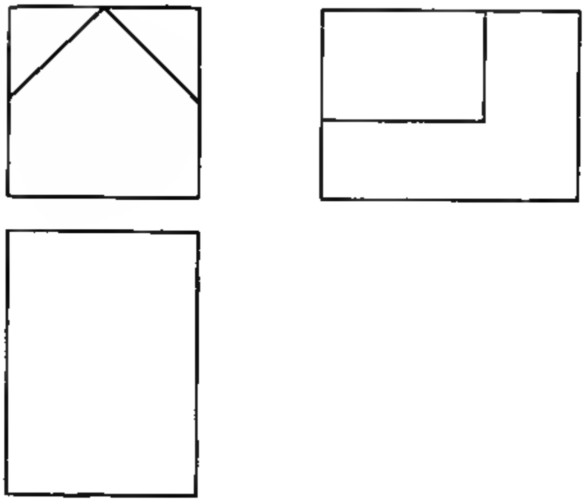
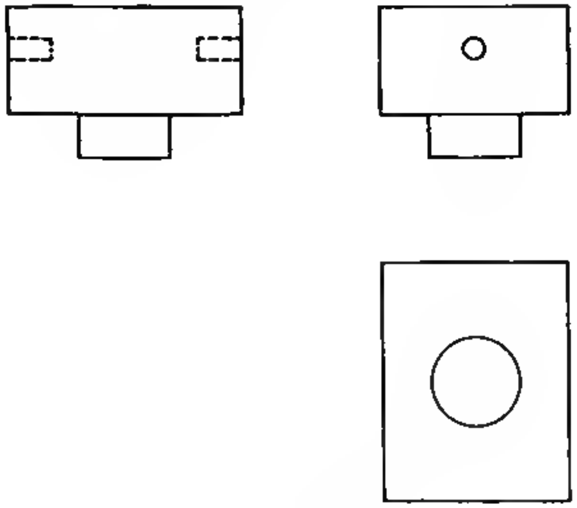


FIG. 24.

Make copies of the following orthographic views, and fill in the missing lines or views. Do not write in this book.



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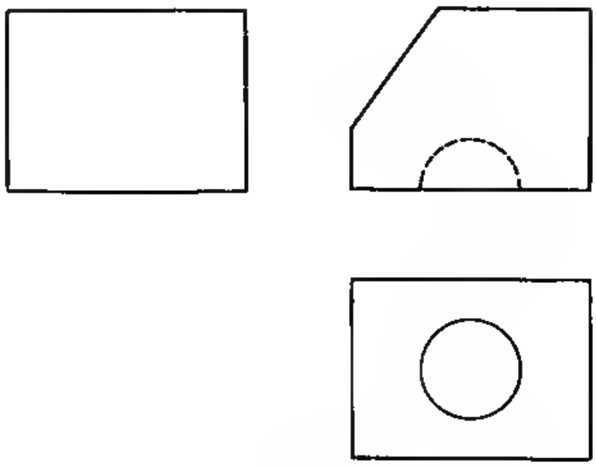

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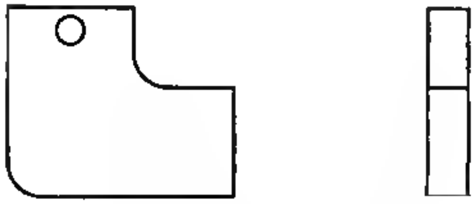

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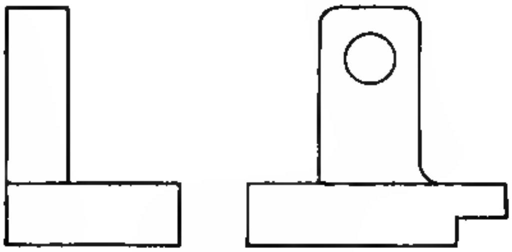


FIG. 28.

4. USE OF ISOMETRIC VIEWS

An isometric view is made by drawing an object as seen at an angle that shows three sides or a three-dimensional view.

Make isometric drawings of the following.

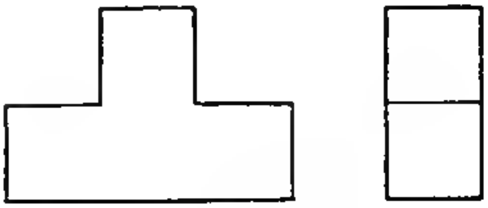


Fig. 29.

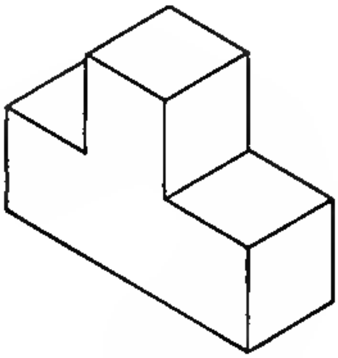


Fig. 30.

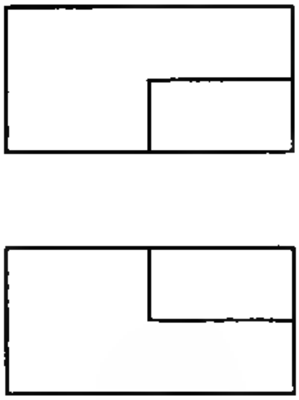


Fig. 31.

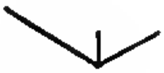
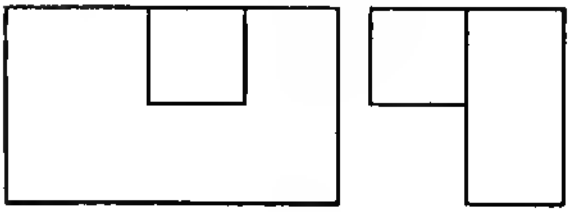


Fig. 32.



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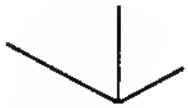


Fig. 34.

Make isometric drawings of the following.

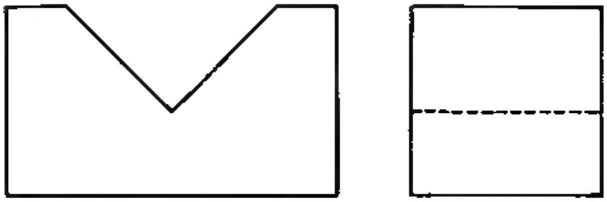


Fig. 35.

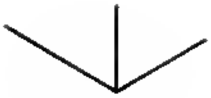
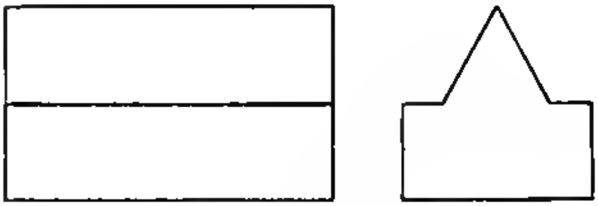


Fig. 36.



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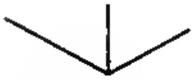


Fig. 38.

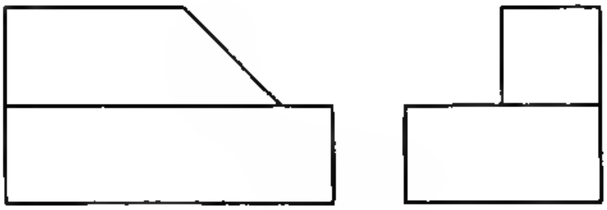


Fig. 39.

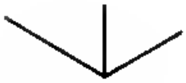


Fig. 40.

Make isometric drawings of the following.

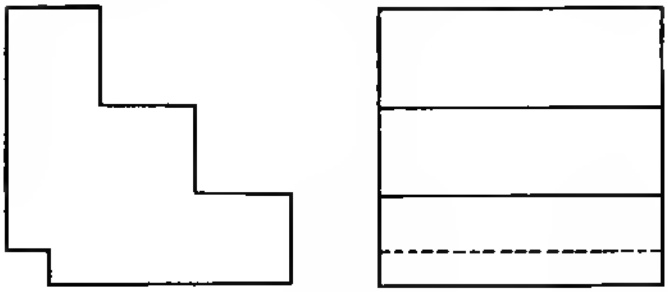


FIG. 41.

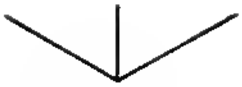


FIG. 42.

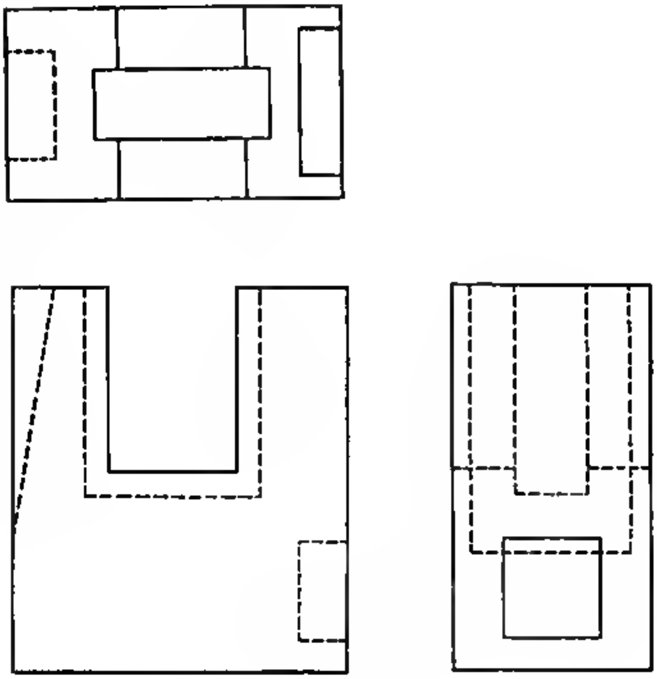


FIG. 43.

FIG. 44.

5. GENERAL INFORMATION ON BLUEPRINTS

In the lower right-hand corner of standard blueprints is the title block. This block gives information regarding the part to be made, as to whether the drawing is full size, half size, or quarter size; the material the part will be made of, such as cast iron, brass, or aluminum; and where the part will be used, either right or left. The company's name appears, and the draftsman's name, so if further information is needed about the drawing he can be consulted.

All notes on the drawing should be studied before starting to work. If a drawing is to be scaled for dimensions, permission from the foreman should be secured and a standard scale always used on the work. A mark under the dimension, such as $\underline{3/8}$ in., is a sign the drawing is out of scale. If small or medium-sized holes are marked *drill*, this indicates the casting will be drilled. If the drawing is marked *bored*, or with an *f* which means "finish," stock should be left on for this, the amount depending on the size and on the material of which the casting will be made. Usually 1/8 in. is left on cast iron as it has a hard scale on the surface and the machinist must have enough material to get under this scale. Steel comes from the foundry very rough and should have 1/8 in. or more finish. Brass and aluminum leave the foundry fairly smooth so 1/16- to 3/32-in. finish is allowed for small castings. Where the print is marked *spot face* or *disc grind*, only about 1/32 in. is added on small work.

If the blueprint calls for a casting 6 in. long with *f* marked on both ends and made of cast iron, the pattern should be made 6 1/4 in. long, allowing 1/8 in. on each end for finish.

If the blueprint calls for a 2-in. hole marked *bore*, or with an *f* on the inside and made of cast iron, the pattern should be made with a 1 3/4-in. hole, allowing 1/8 in. all around for finish.

Blueprints are always standard size:

No. 1 print—8 1/2 by 11 in.
No. 2 print—11 by 17 in.
No. 3 print—11 by 34 in.
No. 4 print—17 by 22 in.

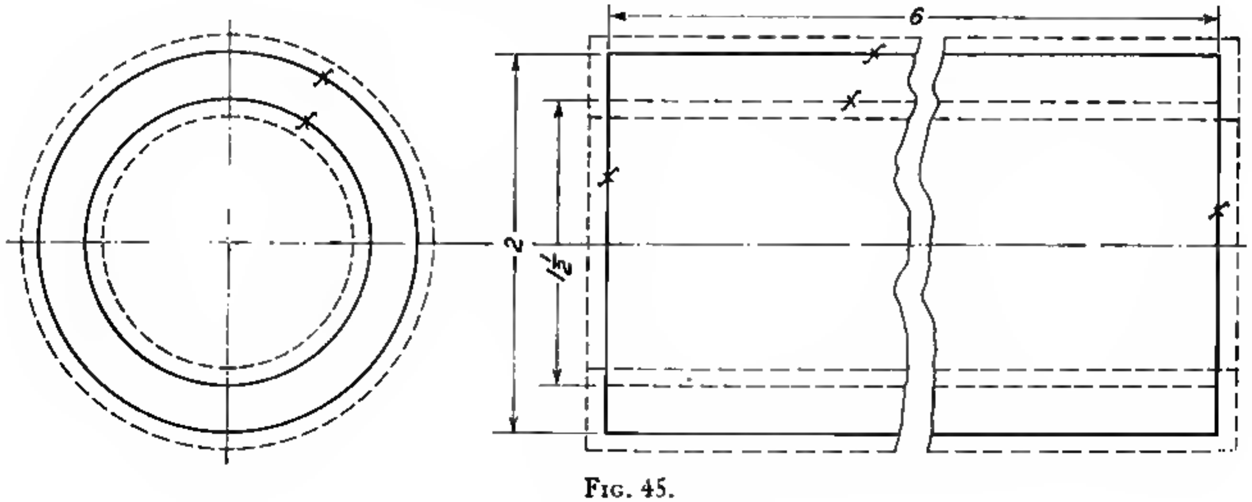


Fig. 45.

6. USE OF CROSS SECTIONS AND VIEWS

It is often necessary to show a cross section or view of a certain section of a pattern that cannot be shown in the regular orthographic projections.

The draftsman shows a section at *A-A* or *B-B*, etc. On the drawing he uses arrows showing which way to look at the section. Imagine cutting through the pattern on line *A-A* and holding it up and looking straight into it as the arrows show in Fig. 46. Cross sections are always cross-hatched as noted, although there are different methods of showing cross sections. See Figs. 46 to 48.

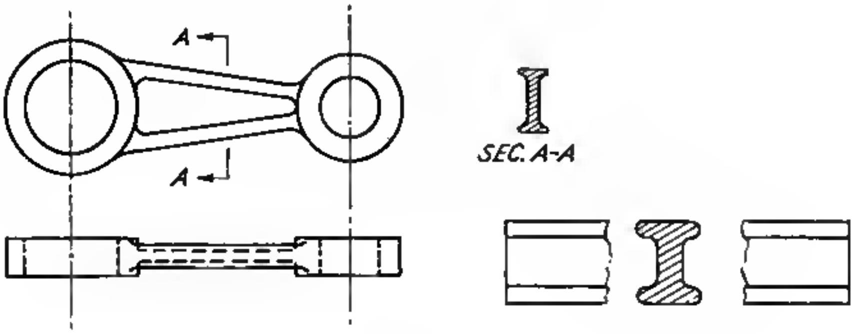


Fig. 46.

Fig. 47.

Fig. 48.

7. SAFETY SUGGESTIONS

1. Horseplay is absolutely forbidden in any pattern shop.
2. Securely fasten all loose neckties, sleeves, or aprons while working around machinery.
3. Keep chisels and gouges away from the edge of the bench and always with the cutting edge turned away from you.
4. When you have finished with the surface gage always put it away.
5. Use a vise rather than your hands to hold work when making heavy cuts.
6. Try to keep your hands out of the direct line of sharp-end tools.
7. Never throw wood with nails in it on the floor or in the scrap box.
8. Keep all oily rags off the floor.
9. Be careful not to bump into a person who is using sharp tools.
10. Help one another when working with long stock at the band saw or other machines.

GENERAL REGULATIONS FOR USING POWER MACHINES

1. Keep safety guards in position when operating machines.
2. Make all adjustments before the power is turned on.
3. Remove all wrenches and loose tools from the machine before operating it.
4. Never distract the attention of anyone using a power machine.
5. Keep the floor around machines clear of waste and scrap wood.
6. Turn off all machines before leaving them.
7. Before it is machined, use great care to see that all lumber is free of nails, sand, metal chips, or loose knots.
8. Always leave a machine with its table square, never on an angle.
9. Use the safety shield when grinding tools on an emery wheel.

SAFE USE OF THE BAND SAW

FIG. 49.—Saw slowly and steadily when sawing to a line.

1. Set the saw guide ¼ to ½ in. above the stock while cutting so as to prevent springing the blade and to permit the saw to follow the line better.

2. Do not try to cut too small a circle on too wide a saw as this is apt to spring or break the saw.

3. When a saw blade breaks, shut off the power immediately and then wait until the wheels stop turning before taking off the guards or taking hold of the blade. Otherwise the blade may get tangled in the wheel and be drawn through your hands.

4. If cylindrical work is not held firmly while cutting it may catch and spring the saw or ruin the job.

5. Always adjust the guide before you start sawing.

6. Never push work through the band saw with hand in line with blade.

SAFE USE OF THE TABLE SAW

FIG. 50.—Two cuts should be made halfway through rather than one cut clear through.

FIG. 51.—Both hands should be used when sawing stock on a table saw.

1. Do not attempt to set the fence or guide with the scale while the saw is running, for the scale may touch the saw and cause an accident.

2. Do not extend the saw through the stock for more than 1/4 to 1/2 in. Otherwise it is apt to catch your fingers while cutting.

3. Use a wood hand or push stick when ripping narrow or thin stock to prevent your fingers coming too close to the saw.

4. Do not try to pick up or push away stock from back of the saw while it is in motion as your fingers or the stock may touch the saw.

5. Always use cross-cut gage when cutting off stock. Otherwise the saw may be sprung or it may catch and throw the stock.

6. Hold cylindrical stock firmly against the guide while cutting to prevent it from catching and spinning.

7. When sizing stock, make two cuts halfway up rather than one cut clear through; for since you cannot see the moving saw it may catch your fingers.

8. Ask for help in sawing large stock. Working alone you cannot always hold the stock steady enough to follow a line exactly. Also you might spring the saw by dropping one end of the stock.

SAFE USE OF THE JOINTER

Fig. 52.—The hand should be kept on top of the stock while jointing or facing work.

1. Do not try to face thin stock on the jointer. Use a hand plane. The jointer will not cut a smooth surface on thin stock which is apt to spring up when the blades come in contact with it.

2. Push the stock through the jointer slowly so that the knives will be permitted to cut the surface smoothly and evenly.

3. Do not run stock less than 6 in. long over any jointer as there is not enough bearing or surface on the table. As the knives strike the stock it will kick back and probably injure your hand.

4. Never run the end grain of wood through the jointer as it will not cut smoothly and the knives will split out the back of the stock.

5. Hold stock against fence while pushing through in order to ensure getting a square cut.

6. Always be sure your hand or fingers never extend over the edge of the stock; for if they do you may sustain a bad cut or even lose a finger.

SAFE USE OF THE DISC SANDER

Fig. 53.—The right-hand side of the sander should be used when possible.

1. Always use the right-hand side of the sander if possible. The left-hand side will throw grit and dust into your eyes.

2. It is impossible to get good results when using the sander instead of a plane. Since the outside of the disc cuts faster than the center, the surface of the stock will be rounded.

3. Do not hold stock in one place too long while sanding as this will burn the paper and make sandpaper grooves on the work.

4. Be sure always to set the sander table square after using it. Otherwise the next man to use the sander may assume that the table is square, and if it is not his job would be ruined.

5. Never use the disc when fresh glue is on the stock. Fresh glue will make the paper slick so it will not cut properly.

SAFE USE OF THE LATHE

FIG. 54.—Patternmaker turning down stock and sizing with calipers.

1. Be sure the tool rest is free from the stock to be turned before starting the motor. There is danger that the stock might strike the rest and break or be thrown out possibly injuring someone.

2. Check the lathe speed before starting the motor. If the lathe is started at high speed with a large faceplate or heavy stock between centers it is apt to cause an accident.

3. Always use high speed for small work to ensure a smooth cut.

4. Before starting to work, make sure the tailstock is tight. Otherwise it will slip back and throw out the work.

5. All wood for turning must be free from loose knots or deep checks. The momentum of the lathe will throw out loose knots or splinters.

6. Hammer the spur center into the end grain of the stock before attempting to start turning. The stock must be held firmly so it will not slip out.

7. Put a drop or two of oil on the dead center before turning. This will keep the center from burning and also from squeaking.

8. Do not attempt to use outside calipers on work unless it is first turned round. The calipers are apt to catch and ruin the job.

9. The tool rest should always be kept close-to the work to help steady the tool.

10. Always stop the lathe when adjusting the tool rest. Otherwise the rest may hit the work while it is in motion and cause an accident.

11. Never use nails but always use screws on a faceplate. Screws will hold the work firm, whereas nails would permit the work to vibrate loose from the faceplate.

12. All glued work *must* be properly set before being turned.
13. Use turning gouge for roughing down stock.
14. Remove tool rest while sanding stock.

SAFE USE OF THE ROUTER

FIG. 55.—Patternmaker using router for cutting between ribs, etc.

1. Hold work firmly on the table while routing in order to prevent the stock from slipping out of your hands and causing an accident or ruining the pattern.

2. Do not try to cut too close to the finished line. Make allowance for finishing stock by hand. Also many times stock should be left for draft.

3. Always be sure the bit is tight in the chuck or it may fly out.

SAFE USE OF THE DRILL PRESS

1. Before starting the motor, be sure the wrench is not in the chuck as the wrench would fly out and cause an accident.

2. Make all adjustments before starting the motor. Otherwise you may drill too deep and ruin the job.

3. Always use slow speed for wood bits. High speed would burn the bit if the hole should become clogged with shavings.

8. GENERAL INFORMATION ON THE CARE OF TOOLS

A good mechanic is known by his tools and by the shape in which they are kept. Purchase good tools and keep them sharp. Skillful use will come with experience.

A patternmaker should have at least two planes—a jack plane and a block plane. When a plane is not in use it should be laid on its side to protect the edge.

Wood bits can be purchased in fast or slow leads. The fine threads at the point will screw the bit into the wood more slowly than the coarse threads. A slow-lead bit will not split thin stock as readily as the fast. Bits are marked in sixteenths from three to sixteen. No. 3 is $\frac{3}{16}$ in., No. 4 is $\frac{4}{16}$ in. or $\frac{1}{4}$ in., No. 5 is $\frac{5}{16}$ in., No. 6 is $\frac{3}{8}$ in., etc.

One leg of the dividers and trammel points should be sharpened a little flat with a chisel edge to mark or cut into the grain. A point will tear and follow the grain of the wood. When dividers and trammels are being set by a scale, one leg should be placed at the 1-in. mark to ensure close measurements.

To set outside calipers, hook one caliper leg on the end of the scale and set the other leg to the dimension wanted. To set inside calipers, put one caliper leg at the end of the scale while holding the scale vertical on the bench, then set the other leg to the dimension wanted.

A hammer or mallet should not be used on paring chisels or gouges as it will split the handle.

All tools should be wiped off occasionally with an oily cloth to keep them from rusting.

When a tool is being ground on the grinder or emery wheel, the index finger can be used as a gage. Then the tool will always be placed back against the wheel in the same position. Get the right angle, and hold the finger there until grinding is finished.

The oilstone should be ground down frequently to get good results in honing.

A patternmaker should have at least five turning tools in his tool chest.

The bench should be cleaned and the stock set in order around it before the worker leaves at night.

PATTERNMAKER'S TOOLS

1. Core-box plane
2. Hand drill
3. Carving tools
4. Gouges
5. Small router
6. Glue scraper
7. Combination gage
8. Putty knife
9. Diagonals or cutting pliers
10. Large-spoke shave
11. Small-spoke shave
12. Pinch dogs
13. Twist bits
14. Pannel saw
15. Countersink
16. Twist drills
17. Turning tools
18. Bench knife
19. Paring chisels
20. Block plane
21. Oilstone
22. Oil slip
23. Jack plane
24. Trammel points
25. Coping saw
26. Hammer
27. Curve
28. Surface gage
29. Monkey gage
30. Shrink rules
31. Pannel gage
32. Outside calipers
33. Inside calipers
34. Large dividers
35. Small dividers
36. Scissor calipers
37. Large outside calipers
38. Combination square small
39. Radius gage
40. Plug cutter
41. C clamps
42. Nail set
43. Bevel square
44. Screw drivers
45. Hermaphrodite calipers
46. Thumb gage
47. Scriber
48. Screw driver bit
49. Triangle
50. Brace
51. Combination set

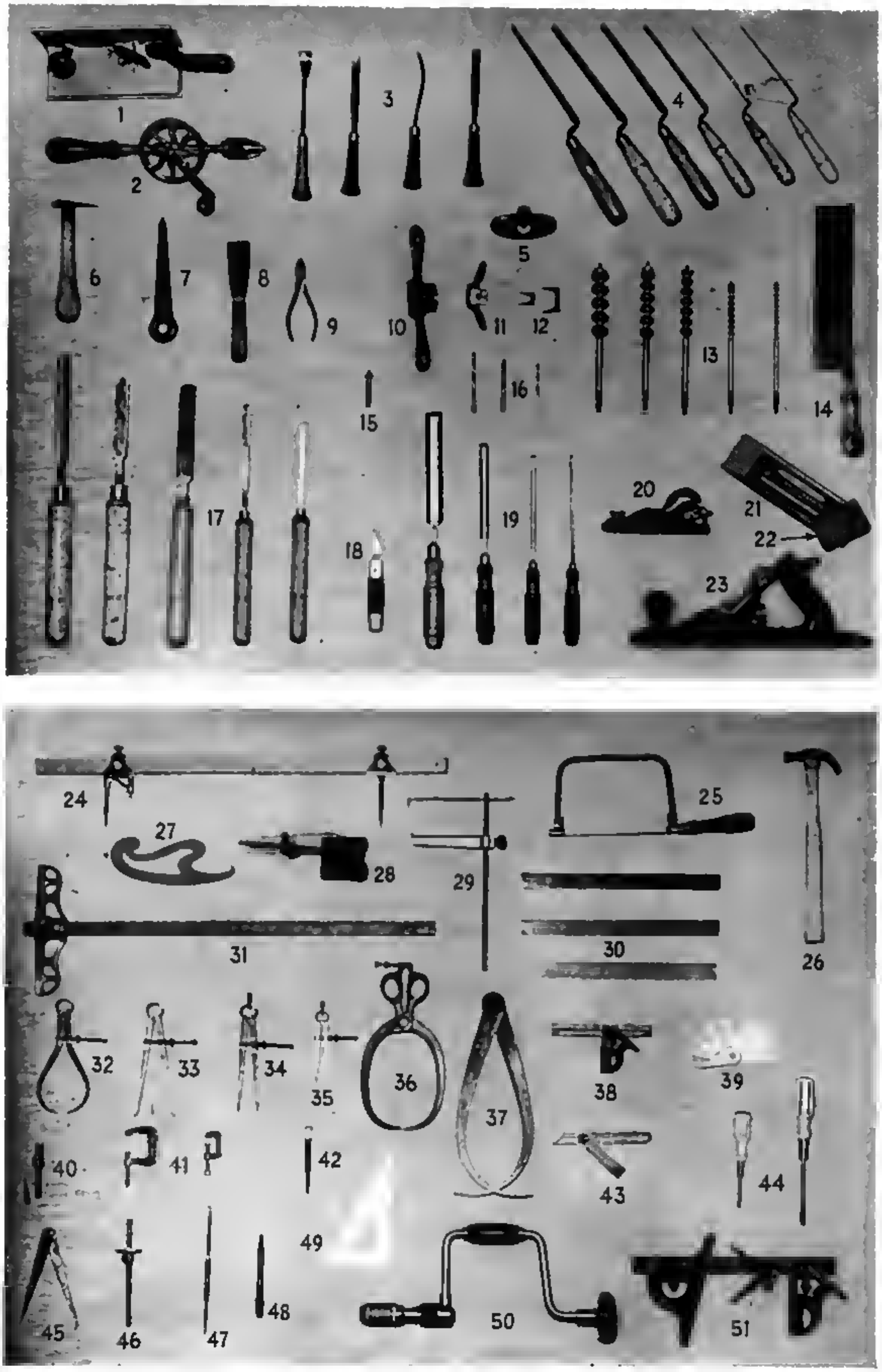


Fig. 56.—Patternmaker's tools.

9. HOW TO GRIND TOOLS

Grinding tools for the patternmaker is somewhat different from grinding tools for the carpenter or worker of hard woods, where there may be knots or grit in the wood. Wood used in patterns is the best grade soft pine, mahogany, or some similar wood. It is straight grained and free from knots and grit.

Tools such as chisels, gouges, carving tools, plane irons, spokeshave blades, and all sharp-edged tools used by the patternmaker can be ground with a longer bevel. This will make a cleaner and smoother cut, for the patternmaker uses chisels and gouges for paring and seldom uses a hammer on them. When a hammer or mallet is used, the tool is forced straight down, thus pushing the grain down before it will cut, while a paring tool is pushed or forced by hand with a sliding motion which cuts clean.

Gouges should be ground very slowly on a cone grinding wheel for best results. Care should be taken not to burn the tool, for when a tool turns blue while grinding, the temper has been removed. The tool should be ground back beyond the blued area and resharpened.

Plane irons should have a straight edge with a slight round on the corners (Fig. 57). This will avoid grooves in the wood caused by the corners digging in.

A sharp-edged tool should not be ground on the grinding wheel any more than necessary. When the tool has been honed until the ground surface has become rounded, it should be ground again on the wheel (Fig. 57). If by accident the edge becomes nicked, the nick should be ground out.

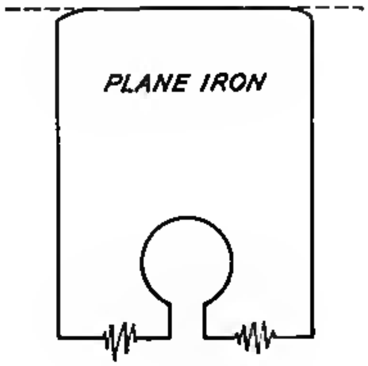


Fig. 57.

Fig. 58.

10. HOW TO SHARPEN CHISELS, PLANE BITS, AND FLAT-BACK TOOLS

Patternmaker's chisels, plane bits, and all other similar flat-back tools should be ground to about a 22- to 25-deg. bevel and honed on the same angle. This is done on a flat oilstone with oil. Use a circular motion which pushes all grit and small particles of steel to the side or off the stone. This is shown in Fig. 59.

Reverse to back of tool several times while sharpening. *Always* keep back of tool flat on the oilstone while honing. When the tool is sharp, strop on leather to take off the wire edge. If the tool leaves scratches in the wood, repeat the honing and stropping.

For oiling the stone, mix oil and kerosene, half and half, so it will not fill up the pores of the oilstone and make it slick.

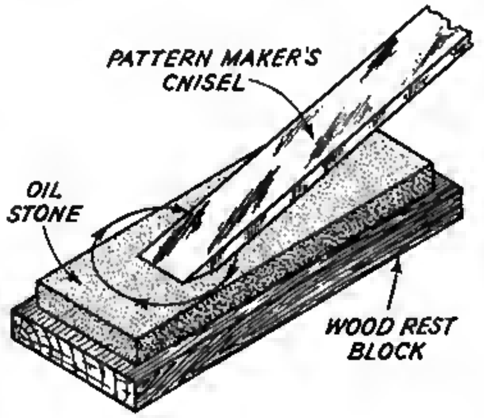


Fig. 59.

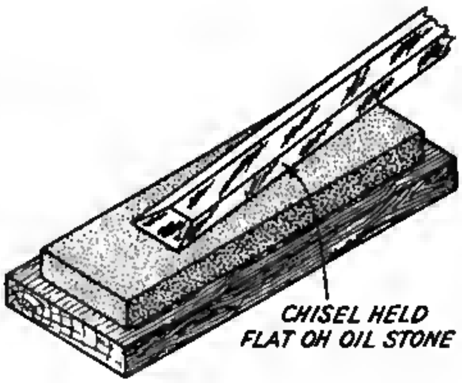


Fig. 60.

11. HOW TO SHARPEN A GOUGE

For this work oil, oil slip, and a strop are needed.

1. Hold the oil slip in the right hand (Fig. 62). Hold the gouge in the left hand with the index finger and the thumb at the top or cutting edge of the gouge, forming side boards, to prevent the oil slip from slipping off and cutting the hand (Fig. 61).

2. Hone up and down, pressing fairly hard against the cutting edge and keeping the slip at the same angle as the gouge is ground.

3. Then, reverse slip on back of gouge (Fig. 63). Be sure to keep slip flat on back of gouge while honing up and down as on cutting edge. Repeat this several times.

4. Use a gouge strop, and strop off wire edges by pushing the strop down the same angle as in honing, on both front and back.

5. Try gouge on block of wood, or work, and if it does not cut smoothly, repeat the process, starting with the oil slip and finishing with the strop as before.

Fig. 61.

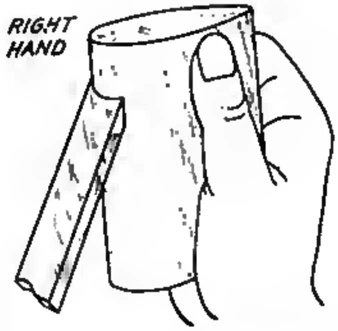


Fig. 62.

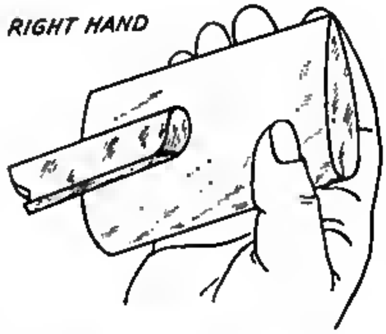


Fig. 63.

Fig. 64.—A chisel should be pushed down at an angle or with a sliding motion if it is to cut smoothly.

Fig. 65.—Twisting the gouges lightly will result in a smoother cut.

12. HOW TO CARE FOR OILSTONES

1. Soak a new stone in kerosene for a day or so before it is used.

2. When an oilstone is worn hollow in the center, straighten it by rubbing it down on No. 1½ or 2 sandpaper, or with emery and oil, on a flat surface until it is even.

3. Use a very light oil or dilute the oil with kerosene and the stone will not become smooth or slick.

4. Put a cover on the oilstone box to keep it free from dust and grit.

MAKES OF STONES USED FOR THIS WORK

Hard Arkansas.—Natural stone; cuts very slowly.

Soft Arkansas.—Natural stone; cuts medium; for general use.

Washita.—Natural stone; cuts medium; for general use.

India.—Manufactured stone in fine, medium, or coarse grades; for general use.

Carborundum.—Manufactured stone in fine, medium, or coarse grades; for general use.

All shapes may be found in each stone, including slips for gouges and carving tools.

13. TYPES AND SIZES OF NAILS, BRADS, AND SCREWS

There are many types and sizes of nails manufactured. The patternmaker uses only a few types but many sizes.

The common wire nail, often called the standard wire nail (Fig. 66), has a flat head and is made of heavy-gauge wire. These nails are used in the pattern shop for rough pattern or core-box framework.

The common wire finishing nail (Fig. 67) has a small head and is made of lighter gage wire. This nail can be set into the wood with a nail set and waxed over for smooth work. Wire nails are recognized and purchased as fourpenny, sixpenny, eightpenny, meaning 4 lb. to 1000 nails, 6 lb. to 1000 nails, etc., and are labeled on the package or keg as 4d., 6d., 8d., etc.

Brads, which are small finishing nails, are manufactured in many different gages and lengths. They are identified as ½–12, meaning ½ in. long and made of 12-gage wire; 1–14 meaning 1 in. long and made of 14-gage wire, etc. The gage used is the Standard steel wire gage.

Wood screws are numbered in the same manner as brads, the difference being in the gage. The Standard American screw wire gage designates the diameter of the screw. ¾–6 F.H.S. is interpreted as flat-head wood screw, ¾ in. long, No. 6 diameter.

Size and Length of Nails

2d. is	1 in. long
3d. is	1¼ in. long
4d. is	1½ in. long
5d. is	1¾ in. long
6d. is	2 in. long
7d. is	2¼ in. long
8d. is	2½ in. long
10d. is	3 in. long
12d. is	3¼ in. long

Length and Gages of Brads

¼ in.				19	20	21	22
⅜ in.			18	19	20	21	22
½ in.	16	17	18	19	20	21	22
⅝ in.	16	17	18	19	20	21	22
¾ in.	16	17	18	19	20	21	22
⅞ in.	16	17	18	19	20		
1 in.	16	17	18	19	20		
1¼ in.	16	17	18				
1½ in.	16	17	18				
1¾ in.	16						
2 in.	16						

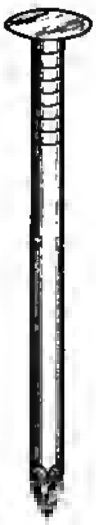


Fig. 66.

Fig. 67.

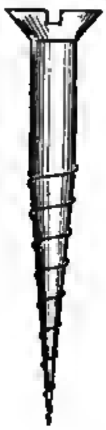


Fig. 68.

14. GENERAL INFORMATION ON SANDPAPER

A great part of the time spent in making any wood pattern can be charged to sanding. Consequently, a good patternmaker should know the various types and grits of sandpaper and for what purpose each should be used.

Sandpaper is made by gluing gritty material, similar to sand, onto a suitable type of paper. The speed with which this abrasive will cut is determined by both the size and sharpness of the gritty particles.

Flintpaper is identified by the yellow color of the abrasive. This material is inferior to red garnet paper as it does not cut as fast, nor does it retain its cutting qualities as well as garnet paper. Consequently, on sanders where it is necessary to eliminate frequent changing, garnet paper is used.

The coarseness or fineness of the sandpaper is determined by the size of the abrasive used. The size of the abrasive kernels are identified on the back of the sandpaper by number. No. 1½ or No. 2 is usually used on the disc grinder. Flint and garnet paper do not use the same grading to determine grit. Below are listed the various grits in each paper, and the difference in cutting qualities can be compared.

Flint	Garnet	
	9/0	
	8/0	very fine
	7/0	
4/0	6/0	
3/0	5/0	
2/0	4/0	finish sanding
0	3/0	
½	2/0	
1	0	
1½	½	rough hand sanding
2	1	
2½	1½	
3	2	
	2½	disc sanders
	3	
	3½	very coarse

For smooth sanding, such as rounding corners, removing scratches or plane marks, No. 0 or 1/2 is suitable in the garnet paper. For finishing a pattern smooth enough for shellac, a finer grit should be used. No. 6/0, 5/0, or 4/0 is then desirable in the garnet paper.

The patternmaker should be able to identify the grit of sandpaper by sight and not have to rely on the stamp on the back.

15. TABLE OF DECIMAL EQUIVALENTS

Finished surfaces are often marked on the blueprint in decimals. All major fractions of an inch should be memorized, such as 1/8 in. is 0.1250, 1/4 in. is 0.2500, 3/8 in. is 0.3750, 1/2 in. is 0.5000, etc.

Small drills, as listed, are used mainly by the patternmaker to drill holes for screws and loose pieces of patterns and core boxes.

Size drill	Fractional size drill, inches	Decimal inches	Fractional size drill, inches	Decimal inches
79	1/64	0.0156	33/64	0.5156
67	1/32	0.0313	17/32	0.5312
55	3/64	0.0469	35/64	0.5469
52	1/16	0.0625	9/16	0.5625
47	5/64	0.0781	37/64	0.5781
41	3/32	0.0937	19/32	0.5937
35	7/64	0.1093	39/64	0.6094
30	1/8	0.1250	5/8	0.6250
27	9/64	0.1406	41/64	0.6406
22	5/32	0.1562	21/32	0.6562
17	11/64	0.1719	43/64	0.6719
12	3/16	0.1875	11/16	0.6875
6	13/64	0.2031	45/64	0.7031
2	7/32	0.2187	23/32	0.7187
	15/64	0.2344	47/64	0.7344
	1/4	0.2500	3/4	0.7500
	17/64	0.2656	49/64	0.7656
	9/32	0.2812	25/32	0.7812
	19/64	0.2969	51/64	0.7969
	5/16	0.3125	13/16	0.8125
	21/64	0.3281	53/64	0.8281
	11/32	0.3437	27/32	0.8437
	23/64	0.3594	55/64	0.8594
	3/8	0.3750	7/8	0.8750
	25/64	0.3906	57/64	0.8906
	13/32	0.4062	29/32	0.9062
	27/64	0.4219	59/64	0.9219
	7/16	0.4375	15/16	0.9375
	29/64	0.4531	61/64	0.9531
	15/32	0.4687	31/32	0.9687
	31/64	0.4843	63/64	0.9844
	1/2	0.5000	1	1.0000

16. GENERAL INFORMATION ON WOOD

Mahogany.—There are about 35 different kinds of wood called *mahogany*, but actually there are only three authentic species of true mahogany. These are West Indian mahogany, tropical American mahogany, and African mahogany.

Tropical American mahogany is the kind used most in patternmaking. The principal supply of this kind comes from British Honduras, Mexico, and the upper Amazon. The best known woods from this region are Mexican mahogany, Tobasco mahogany, and Honduras mahogany. These are choice woods and are used for first-class patterns. They have a straight, close grain and are salmon pink in color when first cut; this color changes to a dark brown with age. From Honduras there also comes a soft, pale mahogany known in some sections as *baywood.*

White Pine.—The best white pine for pattern work comes from the lake states, northeastern states, and the Appalachian region. This wood is soft, even textured, and easy to work with. It does not shrink or swell a great deal from the weather.

There is also a western pine that somewhat resembles the northern pine, but it is not so soft nor so uniform in texture as the northern.

Sugar Pine.—Sugar pine is a California and southern Oregon wood. It has the same outside appearance as the northern pine but it is lighter in color, coarser in texture, and will not cut so smoothly.

Cherry.—This wood comes from the northern states, Florida, and parts of Texas. It is usually of a reddish-brown color and very hard and close grained.

Black Walnut.—This wood, sometimes used in patternmaking, is the American black walnut found in many sections of the United States. The largest quantities come from Illinois, Iowa, Indiana, and Missouri. It is a fairly close grained wood and is uniform in texture.

Hard Maple.—Hard maple is found principally in the lake states and the Northwest. It is light brown in color, very hard, and close grained. Few patterns are made of this wood because it is too hard to work with.

Birch.—There are a few patterns made of birch. It is grown in nearly all the eastern and northern states and in some southern states. This wood is usually very light brown in color, close grained, even textured, and very strong.

Comparable Life of Wood Patterns:

Mahogany usually outlasts pine three to one.
Cherry usually outlasts pine five to one.
Walnut usually outlasts pine five to one.
Maple usually outlasts pine eight to one.
Birch usually outlasts pine eight to one.

17. WOODS USED IN PATTERNMAKING

White Pine.—Probably the best and most used of soft woods.

Sugar Pine.—The second choice in soft wood.

Baywood.—A little harder wood and works very well.

Tobasco Mahogany or Honduras Mahogany.—The best of all hard woods for first-class patterns.

Cherry.—A little harder to work, but makes very smooth patterns

Walnut.—Still heavier and makes very good pattern wood.

Maple and Birch.—The real hard woods; make long-life patterns.

All pattern lumber should be either kiln-dried or air-dried before it goes into patterns. Otherwise it will swell, twist, or warp and ruin the pattern.

Pick straight-grain wood for small carving work.

18. HOW TO MEASURE LUMBER

The unit of lumber measure is the "board foot," which is equal to $\frac{1}{12}$ cu. ft. This measurement is most easily obtained by multiplying the length in feet by the width in feet by thickness in inches. Often numbers may be eliminated by cancellation, thus obtaining the correct answer with short, easy, mental division and multiplication.

Example.—Suppose you had a board 1 by 8 by 18 in.

Solution.—1 in. $\times \frac{2}{3}$ ft. $\times \frac{3}{2}$ ft. $=$ 1 bd. ft.

Example.—Suppose you had a board $1\frac{1}{2}$ by 10 by 36 in.

Solution.—$\frac{3}{2}$ in. $\times \frac{5}{6}$ ft. $\times$ 3 ft. $= \frac{15}{4}$ ft. $= 3\frac{3}{4}$ bd. ft.

Example.—Suppose you had a board 1 in. by 8 in. by 14 ft.

Solution.—1 in. $\times \frac{2}{3}$ ft. $\times$ 14 ft. $= \frac{28}{3}$ ft. $= 9\frac{1}{3}$ bd. ft.

Example.—Suppose you had a board 3 in. by 15 in. by 10.5 ft.

Solution.—3 in. $\times \frac{15}{12}$ ft. $\times 10\frac{1}{2}$ ft. $= \dfrac{157\frac{1}{2}}{4} = 39\frac{3}{8}$ bd. ft.

19. HOW TO PREPARE FLAKE OR GROUND GLUE

For this work, flake or ground glue, a 2-qt. glue pot, and a container are needed.

1. Put 1 qt. of flake or ground glue in a container.
2. Add enough cold water to cover glue. Let soak 10 or 12 hr., or overnight.
3. Pour contents in glue pot, and cook at least 2 hr. before using.
4. Skim off top and discard.

If the glue is too thick, add water until it flows freely.

When glue is too thick, it will not penetrate the wood and a poor glue joint will result.

Glue should be heated to about 150°F.

Be careful not to smear glue on your work. If you do, wipe it off immediately with a clean cloth.

20. HOW TO GLUE PATTERN STOCK

Before being glued, the wood should be dusted well. The glue should be warm and thin enough to spread, as glue penetrates only when hot.

One must work fast after the glue is applied. If the glue is allowed to chill, it will make a poor joint. If clamps are to be used, they should be set and ready to put on at once. If no clamps are used, the pieces of lumber should be rubbed together to get out all the air so that the glue is forced into the wood pores.

If large pieces are to be glued, it is well to warm the stock so that the glue will stay thin until the clamps are applied.

In gluing end wood, a first coat is rubbed into the grain and a second coat added before clamping.

Many types of clamps may be used for gluing operations (Figs. 69, 70).

Pinch dogs are also used in gluing in many cases (Fig. 71).

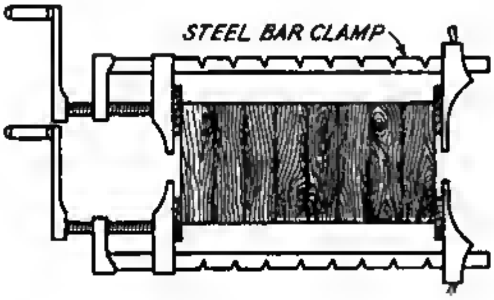


Fig. 69.

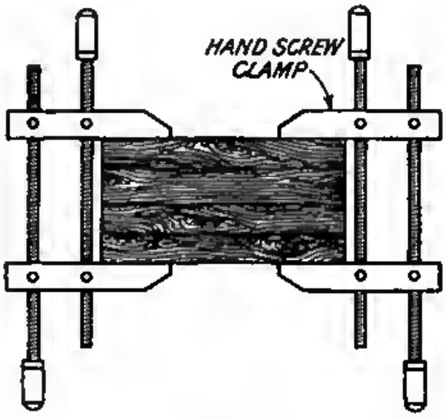


Fig. 70.

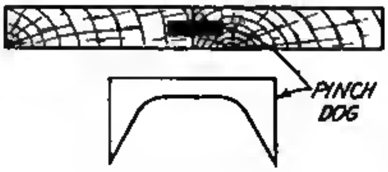


Fig. 71.

21. HOW TO PREPARE SHELLAC

For this work shellac, alcohol, lamp black, oxalic acid, shellac pots, brushes, and a container are needed.

1. How to Cut Flake Shellac. (Shellac originally comes in flake form and has to be cut before using.)

Put 2 or 3 qt. of flake shellac in a container and cover with denatured alcohol. Stir every hour or so until dissolved.

2. How to Mix Yellow Shellac. (In the pattern shop this is called yellow shellac, but commercially it is known as orange shellac.)

a. Fill a container about one-third full of yellow shellac.

b. Thin with alcohol until it spreads smoothly but covers the surface.

c. Add just a pinch of oxalic acid, which clears it up, or makes it clean and light colored.

A level teaspoonful of oxalic acid will clear up 2 or 3 qt. of yellow shellac.

Keep shellac pots and brushes clean.

22. HOW TO FIGURE THE SHRINKAGE OF METALS

As all metals shrink when cooling in the mold, the patternmaker uses a shrink rule which is longer than the standard rule to allow for the shrinkage in the casting.

If a pattern is to be made for an iron casting, one would use a 1/8-in. shrink rule, as cast iron shrinks nearly 1/8 in. for every foot.

If a pattern is to be made for a brass casting, one would use a 3/16-in. shrink rule, as brass shrinks 3/16 in. to the foot.

The first thing to do after getting a blueprint is to find out what kind of material the casting will be made of; then get the right rule. Put all others away, as it is very easy to pick up the wrong rule if it is on the bench.

White metal is one of the few metals with practically no shrinkage—less than 1/32 in. to the foot.

Be sure to figure the shrinkage before starting work.

Material	Shrinkage
Cast iron	1/8 in. per foot
Malleable iron	1/8 in. per foot
Aluminum	5/32 in. per foot
Lead	5/32 in. per foot
Copper	3/16 in. per foot
Brass	3/16 in. per foot
Bronze	3/16 in. per foot
Steel	1/4 in. per foot
Tin	1/12 in. per foot

23. HOW TO USE TRADE TERMS

Cope and **drag.**—These terms are used on all patterns and refer to the top and bottom of the flask used by the molder.

Cope.—This term refers to the top and follows the parting line *AAA* (Fig. 72).

Drag.—This refers to the bottom part and follows parting line *AAA* (Fig. 72).

Web.—A term used in many patterns. May be explained as a sheet of metal connecting heavier sections (Fig. 72).

Boss.—Meaning a circular prominence, knob, or stud (Fig. 74).

Green sand core.—The term used where a taper can be made in a hole allowing the sand to stand in the mold and the metal to run around it forming a hole in the casting.

Core or **dry sand core.**—A molded body of sand mixed with a binder which has been baked until dry and firm. The metal flowing around this core in a green sand mold will form a hole or impression in the casting the shape of the core (see Fig. 74).

Draft.—Refers to the taper put on the pattern so that it will draw out of the sand without disturbing it and causing a rough surface.

Back draft.—The term used when the draft is reversed and the pattern cannot be drawn out of the sand without making a rough mold.

Rib.—Connecting strip or reinforcement between two larger pieces (Fig. 74).

Fillet.—Refers to a round corner used in patterns as shown (Fig. 73).

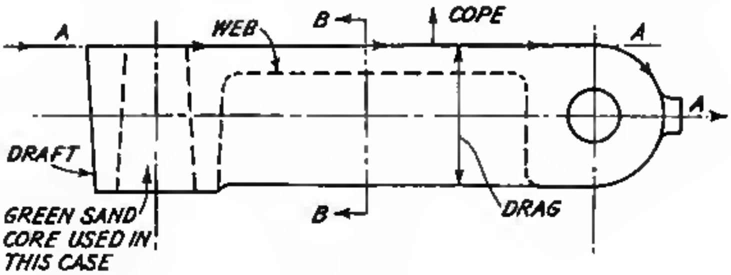


Fig. 72.

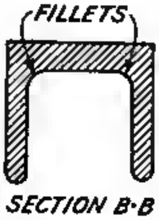


Fig. 73.

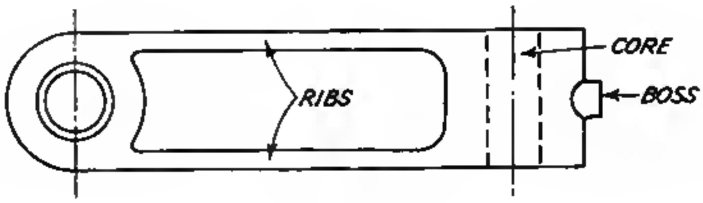


Fig. 74.

24. HOW TO DIFFERENTIATE BETWEEN VARIOUS TOOLS AND EQUIPMENT

Flask (Fig. 75).—A split wood or metal box or frame used by the molder to get a sand impression from the pattern. The top half is called the *cope* and the bottom half the *drag*.

Bottom board or **mold board** (Fig. 75).—A board on which the pattern lies under the drag while ramming up the mold. It is also used on the top while rolling the mold over.

Swab (Fig. 76).—A rubber bulb with a brush connected to it. The bulb is filled with water and is used to dampen the edge of the mold to keep sand from breaking off.

Riser and **sprue** (Fig. 77).—The pins used to make holes through the cope. Metal is poured in the sprue hole and comes up in the riser hole as the mold fills. The riser supplies metal to the casting as it shrinks, and it also holds heat on thin castings so some parts cannot cool more quickly than others.

Riddle (Fig. 78).—A round frame with a screen on the bottom made to sift sand on the face of the mold.

Draw screw (Fig. 79).—A small screw or spike used to rap and draw small patterns out of the mold.

Trowel (Fig. 80).—A tool used by the molder to smooth off or patch the sand mold if broken. There are different styles of trowels used.

Rammer (Fig. 81).—A wooden tool used by the bench molder for tamping sand into the mold. The wedge end is called the *peen*, and the larger end is called the *butt*.

Gate cutter (Fig. 82).—A curved piece of metal used for cutting the gate from the sprue or riser to the mold. The *gate* is the channel to allow metal to flow from the sprue to the mold.

Slick (Fig. 83).—A round tool used to patch molds, pick out loose sand, and shift or place cores, etc.

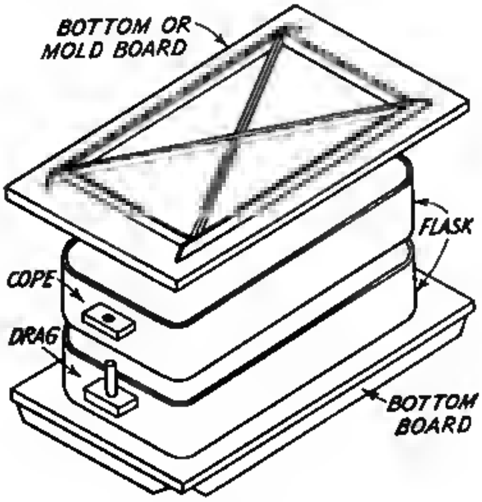


Fig. 75.

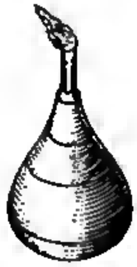


Fig. 76.

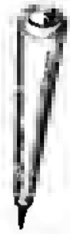


Fig. 77.

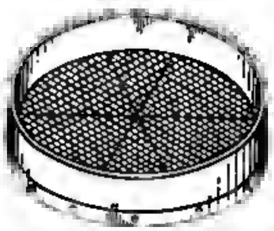


Fig. 78.

Fig. 79.

Fig. 80.

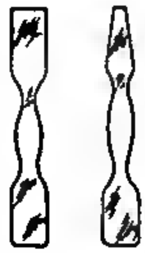


Fig. 81.

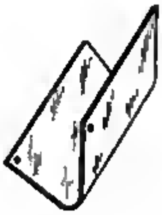


Fig. 82.

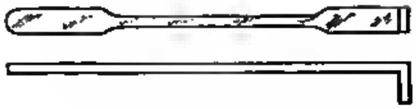


Fig. 83.

26. HOW TO USE FOUNDRY TRADE TERMS

In order to make patterns intelligently, it is essential for the patternmaker to understand the tools, terms, and equipment used in the foundry.

Cast iron.—This term applies to any iron that is poured while molten into a mold of a desired shape and allowed to cool and harden. However, there are different kinds of cast iron, and each has its characteristics.

Gray iron.—Gray in color and very brittle. It is used for heavy castings such as woodworking and metalworking machinery. Its tensile strength is 16,000 to 20,000 lb. per square inch.

Malleable iron.—Gray in color and much stronger than gray iron after it has been annealed. Castings can be made with thinner walls, ribs, or webs. It will bend before it will break. The tensile strength ranges from 40,000 to 55,000 lb. per square inch.

White iron.—Malleable iron before it has been annealed, and very light in color. It is seldom used as it comes from the mold.

Alloy Mixtures.—Elements used, with their percentages (see page 178).

Foundry.—An iron foundry is the place where different iron-alloy castings are molded or cast (see page 1).

Brass foundry.—The foundry where brass castings are made (see page 49).

Aluminum foundry.—The foundry where aluminum castings are made (see page 49).

Core room.—A room, usually connected with the foundry, where the dry sand cores are made and baked in the core oven.

Cleaning room.—Where the small castings are dumped into revolving iron barrels called *tumblers* or *rattlers*. The castings tumble around in the barrel, which rattles or cleans the sand from them.

Flask.—A flask consists usually of two parts known as the *cope* and *drag* (page 32).

Snap flask.—An ordinary flask consisting of two parts, cope and drag. It is hinged and can be opened and lifted off the mold (see page 131).

Three-part flask.—A three-section flask whose top is called the *cope*, the bottom called the *drag*, and the center section the *cheek*. This flask is used only in special work.

Slip jacket.—A thin metal frame to slip over the sand mold after the flask is removed, to protect and hold the mold together during pouring.

Clamps.—Foundry clamps are not adjustable. They are made of bar steel, bent at right angles on both ends, and are tightened by driving wood wedges under them (see page 167).

Weights.—Weights are used on top of small molds during pouring not only to hold the mold together but also to protect the edges. They are made of gray iron about 1 in. thick (see page 167).

Green sand molding.—Molds are made up of damp sand, and the metal is poured while the sand is in this state (see page 167).

Bench molding.—Small green sand molds are made up at the molder's bench. This bench is on small wheels and straddles the sand pile.

Floor molding.—When the molding is too large to be done at the bench and is done on the foundry floor, the process is called floor molding. This is also green sand molding (see page 167).

Pit molding.—A pit is dug in the foundry floor for molding very large castings. This is green sand molding. Usually there is much core work in such jobs.

Skin-dried molds.—Green sand molds with the face of both cope and drag dried out by the use of a gas flame are termed skin dried. The face of the mold thus becomes hard. This method is usually used in match plate work where smooth castings are required.

Squeezer or molding machine.—A large floor machine, taking the place of a bench, squeezes or rams the sand into the mold by hand or air leverage.

Match plate.—A plate or board is used between the cope and drag with half the pattern on each side or at the paring line. The mold is rammed up, then the plate is removed and the mold closed and poured. Many patterns can be put on a plate; if four patterns are on the plate, four castings can be poured at one time (see page 131).

Vibrator.—A small electric or air rapper, usually attached to the match plate, vibrates or jars the pattern loose from the sand. It is used mostly in production work (see page 131).

Venting.—Holes are made in either the cope or drag, usually the cope side, to let gas escape while the metal is being poured (see page 167).

Core plate.—Gray iron or steel plate used to dump the cores on; also used while baking the cores in the oven.

Hand ladles.—Small iron or steel containers used to carry small quantities of hot metal to the molds (see page 167).

Bull ladles.—Large containers to carry hot metal to medium-size molds. They must be carried by two men (see page 167).

Chill.—A piece of metal rammed up in the mold against the pattern. As the molten metal strikes this piece of metal, it chills or cools rapidly and becomes very hard.

Core drier.—An iron form to hold the core in shape while baking, much the same as half a core box. The core is dumped into the drier and put in the oven to bake.

Core wash.—A graphite mixture painted on baked cores before they are put into the mold; makes smooth casting.

Weak sand.—Sand that will not hold together in the mold (not sharp).

Burnt sand.—Sand that has been discarded by the foundry (worn out).

Rapping.—Jarring or loosening the pattern in the mold so it will draw without disturbing the sand around it.

Facing.—Powder used on a pattern or parting to keep it from sticking.

Follow board.—Board or frame built to the parting line of the pattern; usually used in irregular or crooked parting lines.

Fin.—Small projection of iron that runs between cores, mismatched cores, or poor joints.

Bars.—Strips placed in the cope half of the flask to hold the sand while the mold is lifted or parted (see page 167).

Blowhole.—A flaw in the casting caused by the gas and steam, generated in the mold from the moisture in the sand, blowing back into the molten metal. Proper venting will usually eliminate this.

26. HOW TO USE DRAFT

Draft is a slight taper put on all vertical surfaces of patterns to enable the molder to remove the pattern from the mold without disturbing the sand around it.

A pattern in the drag side of the mold can be drawn from the sand with very little draft, although it should not be less than $\frac{1}{16}$ in. to the foot. A pattern in the cope side which cannot be split should have more draft. It should be given as much as possible without distorting the shape or showing up too plainly on the casting.

Core prints in the cope should have 8- to 10-deg. draft, as the molder cannot see when setting the cope. A good policy is always to have 1-deg. draft on all parts of the pattern in the drag. Core boxes should have 1 deg. all over so the core maker can remove the core sand smoothly, ready for the core oven.

Core prints should be made with adequate support so the core will not crush into the green sand. When a core stands vertical in the mold, the drag print should be longer than the cope print. This extra length will hold the core firm and erect while the cope is being lowered.

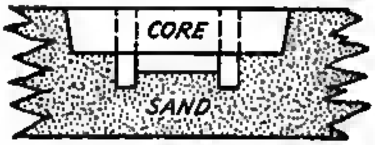


Fig. 84.

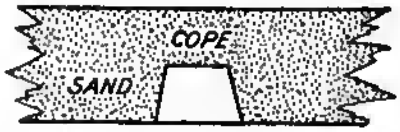


Fig. 85.

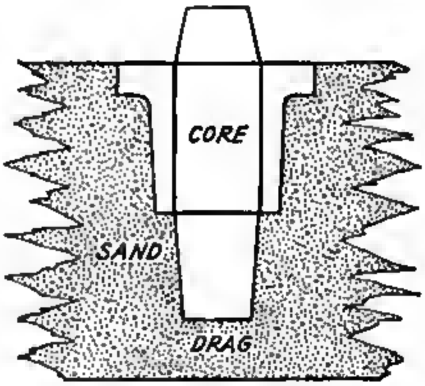


Fig. 86.

27. HOW TO USE RUNNERS AND GATES

A molder often has several small patterns to mold. Rather than ram up several molds with one pattern in each mold, the molder should put the several small patterns in one mold. After he has separated the mold and lifted the patterns out, he should cut a U-shaped trough from the sprue (this is where the metal is poured into the mold) down the center of the mold. This U-shaped trough is called a *runner*. Then smaller U-shapes are cut in the mold from the runner to the cavities where the patterns are drawn out. These small U-shapes are called *gates*. After the mold has been poured and cooled, these gates are sawed and ground off.

28. HOW TO GET OUT SMALL STOCK

For this work a jointer, table saw, band saw, scale, hand plane, and lumber are needed.

1. Cut out on a band saw approximately the size wanted, always a little larger than the actual size needed.
2. Run one face and one edge through jointer (no end grain).
3. Set table saw about $\frac{1}{32}$ in. larger than the size wanted from the inside tooth of the saw; start the saw and always push it through. Never draw it back, as it may catch and cut your hand or throw the piece of stock. *Example:* If you need a piece of stock 1 in. thick, set the saw at $1\frac{1}{32}$ in. This will give you $\frac{1}{32}$ in. to clean up with a hand plane. The jointer will cut the edge square, ready for the layout of the work.
4. Always have one edge square from which to work.
5. Stock less than 6 in. long should he dressed down with a hand plane.

29. HOW TO LAY OUT SMALL PATTERNS

After the stock is out and one edge square (which is the working edge), mark in all parallel lines from the working edge with a gage.

A square should be used on the working edge to get perpendicular lines, using a knife to draw the lines. (Pencil lines will soon rub off and the center lines, which may be needed later, may be lost.) The knife lines may be drawn more clearly with a wedge or chisel-point pencil.

It is a good practice to lay out the center lines on both sides while you have the working edge and before the gage is changed. All radii are then drawn in, and the form or shape of the pattern, as in the blueprint. Center lines are marked on blueprint as ℄.

Work from one edge only.

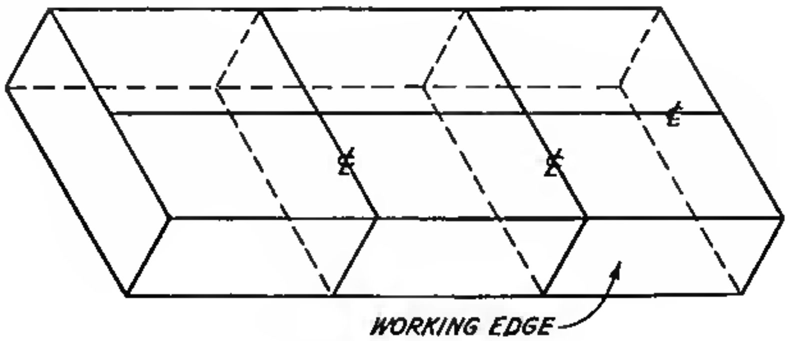


FIG. 87.

30. HOW TO LAY OUT AND CUT ROUND HOLES

For this work a band saw, table saw, drill press, sander, square, gage, scale, knife, dividers, gouge, bits, and sugar pine are needed.

1. Get out stock.
2. Lay out parallel center lines on both sides with a gage. Use only one edge, which is the working edge.
3. Lay out perpendicular center lines on both sides with a square and knife.
4. Scribe circles, sizes shown on drag side.
5. Scribe each radius on the cope side $\frac{1}{32}$ in. smaller than on the drag side.
6. Lay out outside lines of the pattern on the drag side.
7. Bore out holes with wood bits. Use bits at least $\frac{1}{16}$ in. smaller than the drawing shows.
8. First cut out to line, with a sharp gouge, all holes on cope side.
9. Cut out to line the holes on the drag side.
10. Cut straight through from the large size to the smaller size, using a taper mandrel with crayon to find high places.
11. Wrap sandpaper around same taper mandrel and sand. This will assure you of a straight, round hole.
12. Band saw outside, leaving about $\frac{1}{16}$ in. of stock all around on cope side.
13. Set sander table 1 deg. up and sand all around to this line.
14. Sandpaper thoroughly all over and shellac.

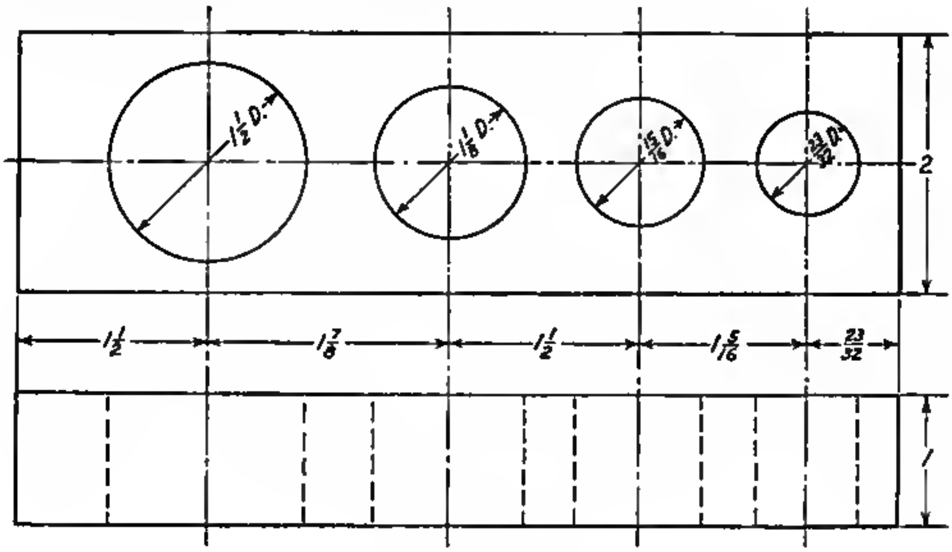


Fig. 88.

31. HOW TO LAY OUT AND CUT SQUARE HOLES

The tools needed for this work are band saw, table saw, drill press, sander, square, gage, scale, knife, dividers, chisels, bits. The material should be sugar pine.

1. Get out stock.
2. Lay out center lines.
3. Scribe circles the size of square holes shown (on drag side).
4. Scribe each radius on cope side 1/32 in. smaller than on drag side.
5. Square and 45 deg. all lines to complete squares as shown.
6. Lay out outside lines on drag as shown in drawing.
7. Bore out with wood bits for square holes. Use bits at least 1/16 in. smaller than the layout shows.
8. Cut out to line, with a sharp chisel, all holes on cope side.
9. Cut from drag side straight through to other line.
10. Band saw outside, leaving about 1/16 in. stock all around on drag side.
11. Set sander table 1 deg. up and sand all around to this line.
12. Sandpaper thoroughly all over and shellac.

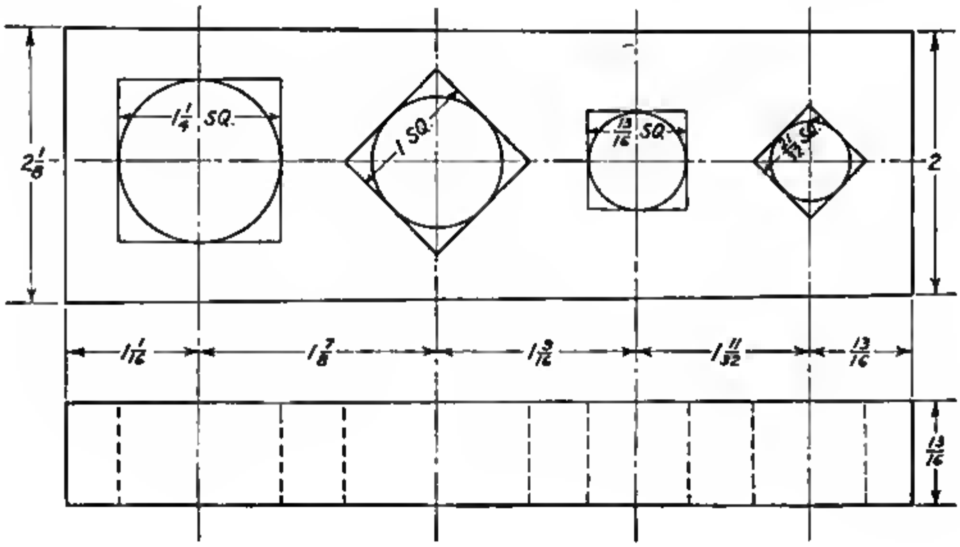


Fig. 89

32. HOW TO SHELLAC AND WAX PATTERNS AND CORE BOXES

For this work shellac, wax, sandpaper, waxing irons, and an alcohol lamp are needed.

1. Shellac the pattern yellow. Allow it to dry thoroughly. Then sandpaper all over with fine or worn-out sandpaper.
2. Fill all nail holes, poor joints, or flaws in the wood with wax.
3. Rub fillets in corners, as blueprint shows, by using waxing irons as shown in Fig. 90.

Fig. 90.—Waxing iron.

Warm the iron over a lamp, not too hot but just warm enough to smooth wax out. Rub fillets into the corners, pressing fairly hard to smooth out waves.

Leave square corners in pattern work when absolutely necessary. Sand and scrape off any surplus wax, which should leave it very smooth.

4. Give the pattern a second coat of shellac. This time the pattern itself and the core prints should be contrasted in color. If the pattern is to be yellow, the core prints should be black. If the pattern is to be black, the core prints should be yellow. On split patterns the parting is always yellow on the cope half, and the core or metal line is always shellacked in on the drag half. This is known as the molders' blueprint.

When the second coat is thoroughly dry, sandpaper as before with worn-out sandpaper very lightly so as to have a very smooth surface.

5. Give a third coat of shellac, which should leave the work with a glasslike finish.

Make patterns of wood, not of wax.

Size of Fillets

No. 1 is 1/16 in.	Use 1/8 wax iron
No. 2 is 1/8 in.	Use 1/4 wax iron
No. 3 is 3/16 in.	Use 3/8 wax iron
No. 4 is 1/4 in.	Use 1/2 wax iron
No. 5 is 5/16 in.	Use 5/8 wax iron

33. HOW TO USE LEATHER FILLETS

In all first-class patterns, leather fillets are used rather than wax. Leather fillets are made in practically all sizes and numbered the same as wax fillets. No. 1 is $\frac{1}{16}$ in. radius, and they run to No. 16, which is 1 in. radius.

Leather fillets may be glued or shellacked in. First fit the fillet in place. Then apply glue or shellac on the underside. If the fillets are glued in, work fast while applying glue. Do not be too particular about covering the entire surface; for one can pick up the end of the fillet with one hand and draw it through the thumb and forefinger of the other hand, thus distributing the glue evenly, hitting all bare places, and at the same time removing excess glue.

Start the fillet at one end and rub in with fillet iron, as is done with wax. Dip the fillet iron in water occasionally and it will rub in better. Wipe out all fillets with a damp cloth to clean off any surplus glue on the edges of the fillets. If fillets are to be shellacked in, use fairly thick yellow shellac and shellac the corners of the pattern as well as the fillet itself. Wait until the shellac feels sticky, then put in place and rub in with fillet iron. Clean off all surplus shellac with a clean cloth and sandpaper before shellacking the pattern.

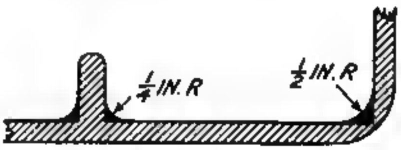


Fig. 91.

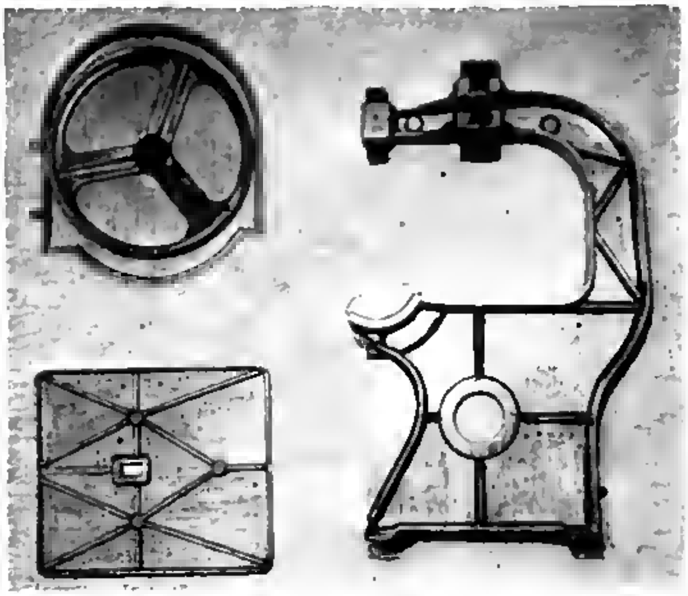


Fig. 92.—Band-saw patterns. Note the leather fillets.

34. HOW TO LETTER AND NUMBER PATTERNS

When letters or numbers, such as the manufacturers' name and location, are wanted on castings, they will first be put on the pattern. If the letters are very large, they should be cut from wood and glued on the pattern at the proper place. Medium or small letters can be purchased from a pattern or foundry supply house. These are cast from white metal or lead and made in many sizes and types. For fastening them to the pattern, shellac or lacquer and brads should be used. Letters and numbers are measured from the center of the face.

Cross-sectional view of different styles:

Style	Size
Tablet	1/4 to 3 in.
Hair line	3/32 to 1 in.
Sharp-face gothic	1/8 to 3 in.
Roman	1/8 to 3 in.
Flat-face gothic	1/4 to 1 in.
Doric half round	1/2 to 3 in.

Fig. 93.

34A. HOW TO USE BLUEPRINTS

Make a wood pattern from each of the following blueprints. Be sure to select the correct shrink rule for each job. Using a good grade of pine or mahogany, make all patterns accurately from the blueprint. Work from center lines when possible. Do not try to scale any blueprints in this book as some have been reduced in size to fit. All necessary dimensions are shown on each blueprint. Do not try to rush, as good workmanship is very important.

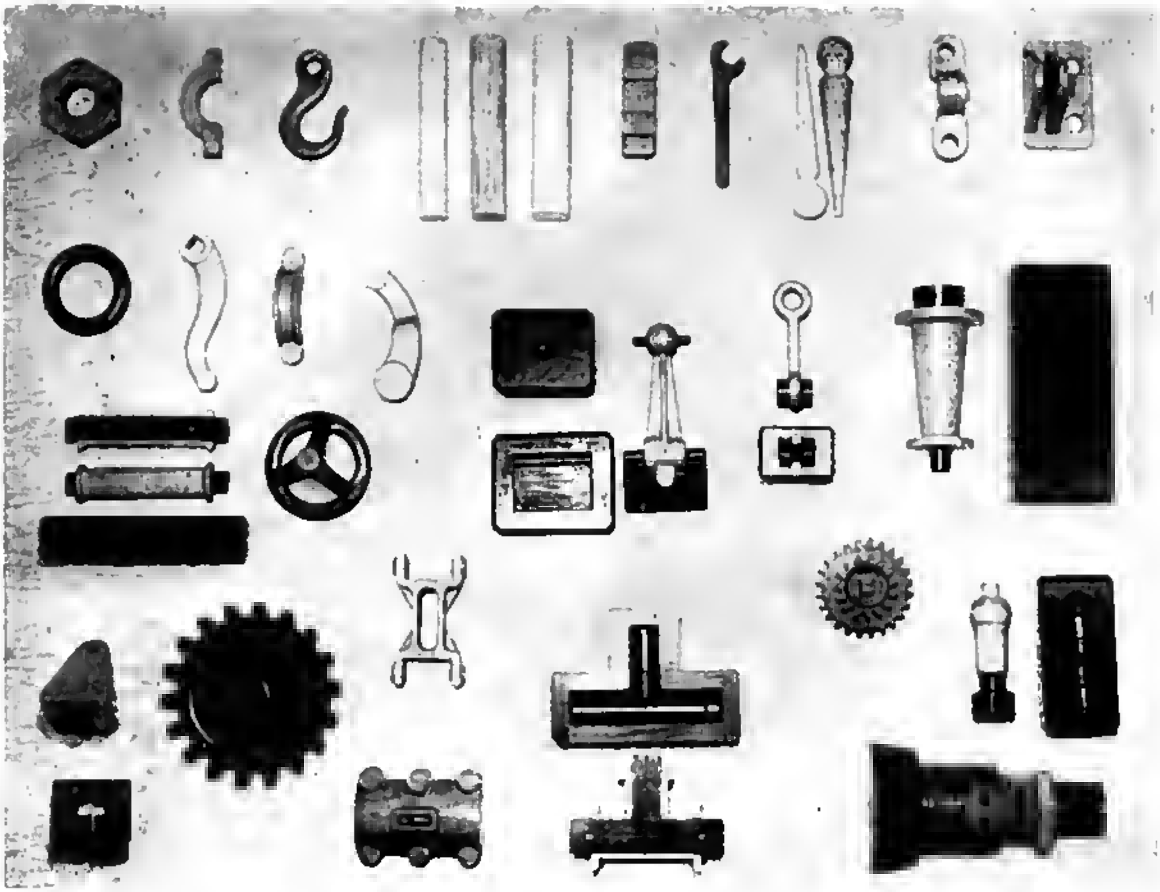
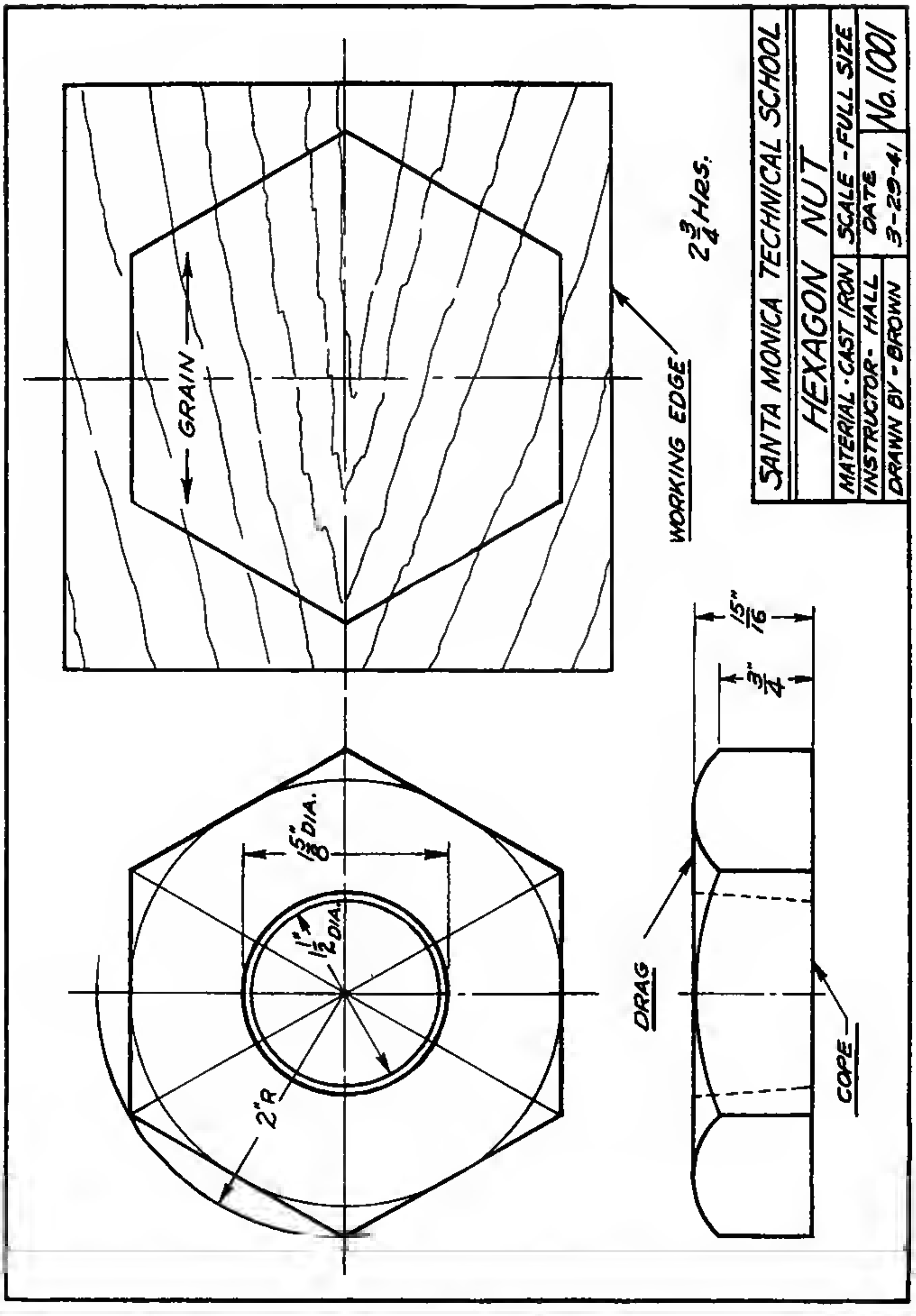


Fig. 94.—Patterns 1 to 9 on the top row are illustrations of the first nine pattern lessons.

Fig. 95.—Half of pattern for water-cooled exhaust manifold with core boxes.


SANTA MONICA TECHNICAL SCHOOL
HEXAGON NUT
MATERIAL - CAST IRON
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE
3-29-41
DRAWN BY - BROWN
No. 1001
2 3/4 HRS.
GRAIN
WORKING EDGE
1 5/8" DIA.
1 1/2" DIA.
2"R
DRAG
COPE
15/16"
3/4"

35. HOW TO CHECK PATTERNS

Before the pattern is handed in to the checker or foreman as finished, the patternmaker should go over his work for a final check. If it is a small pattern, hold it directly over the blueprint first, tipping it to match all views on the print. This will help in seeing if any projections such as hubs, bosses, or ribs are missing. Then take the shrink rule and check the dimensions between centers, and the length, width, and the sizes of all these projections.

Do not overlook any finish marks or notes on the drawing, such as cast solid, spot face, disc grind, make right hand only, left hand only, or both.

Check the size of the core prints to see if finish has been allowed where it is marked on the drawing. Make sure there is enough draft on both the pattern and the core boxes. Go over the size and length of core boxes, the size of fillets, the radii on ribs, etc. These can be checked very closely by eye. A last-minute check on the job may save money and time for the company, embarrassment, and even one's job.

After each pattern has been completed it should be rammed up, both cope and drag, and the cores made and set in the mold when required. A patternmaker must understand molding and core work as well as pattern work. One cannot make patterns correctly unless he knows how they are used by the molder and core maker.

36. HOW TO MOLD A ONE-PIECE PATTERN WITH GREEN SAND CORE

1. Lay pattern (Fig. 96) on the bottom board with drag side up.
2. Dust pattern with parting sand, and set the drag side of flask on the board, pins down.
3. Riddle enough sand in the drag to cover the pattern.
4. Fill the drag heaping full of sand, not riddled.
5. Ram around edges first to bring the sand around the pattern and pack it against flask.
6. Fill, ram to the top, and strike off (Fig. 97).
7. Put board on and turn it over (flask and both boards).
8. Remove top board. Set on cope. Set sprue and riser pins. Dust.
9. Riddle sand on top. Fill, ram, and strike off as on the drag side (Fig. 98).
10. Pull out sprue and riser pins, and round the edges, eliminating loose sand around the holes.
11. Pick off cope very carefully, and set it on edge.
12. Drive draw pin into the pattern, and rap on all sides to loosen the pattern.
13. Draw pattern out very slowly. Try not to touch the sides of the mold with the pattern.
14. Cut gates to sprue and riser. See that all loose sand is off the face of the mold, and replace cope (Fig. 99).

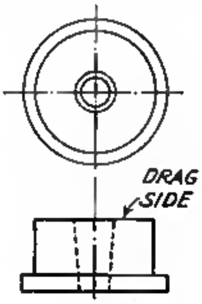


FIG. 96.

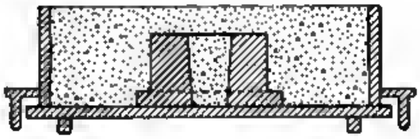


FIG. 97.

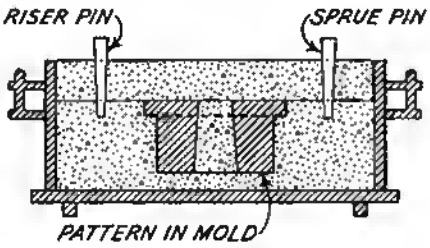


FIG. 98.

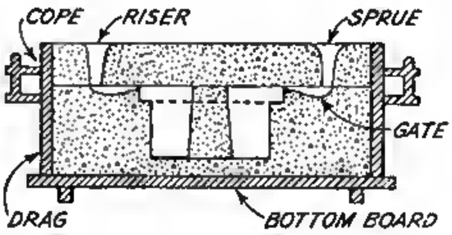


FIG. 99.

Fig. 100.—Molding small gear.

Fig. 101.—Operation 1. Pattern laying on bottom board.

Fig. 102.—Operation 2. Ramming up drag half of mold.

FIG. 103.—Operation 3. Cutting sand to parting line.

FIG. 104.—Operation 4. Applying parting sand.

FIG. 105.—Operation 5. Applying cope half of flask.

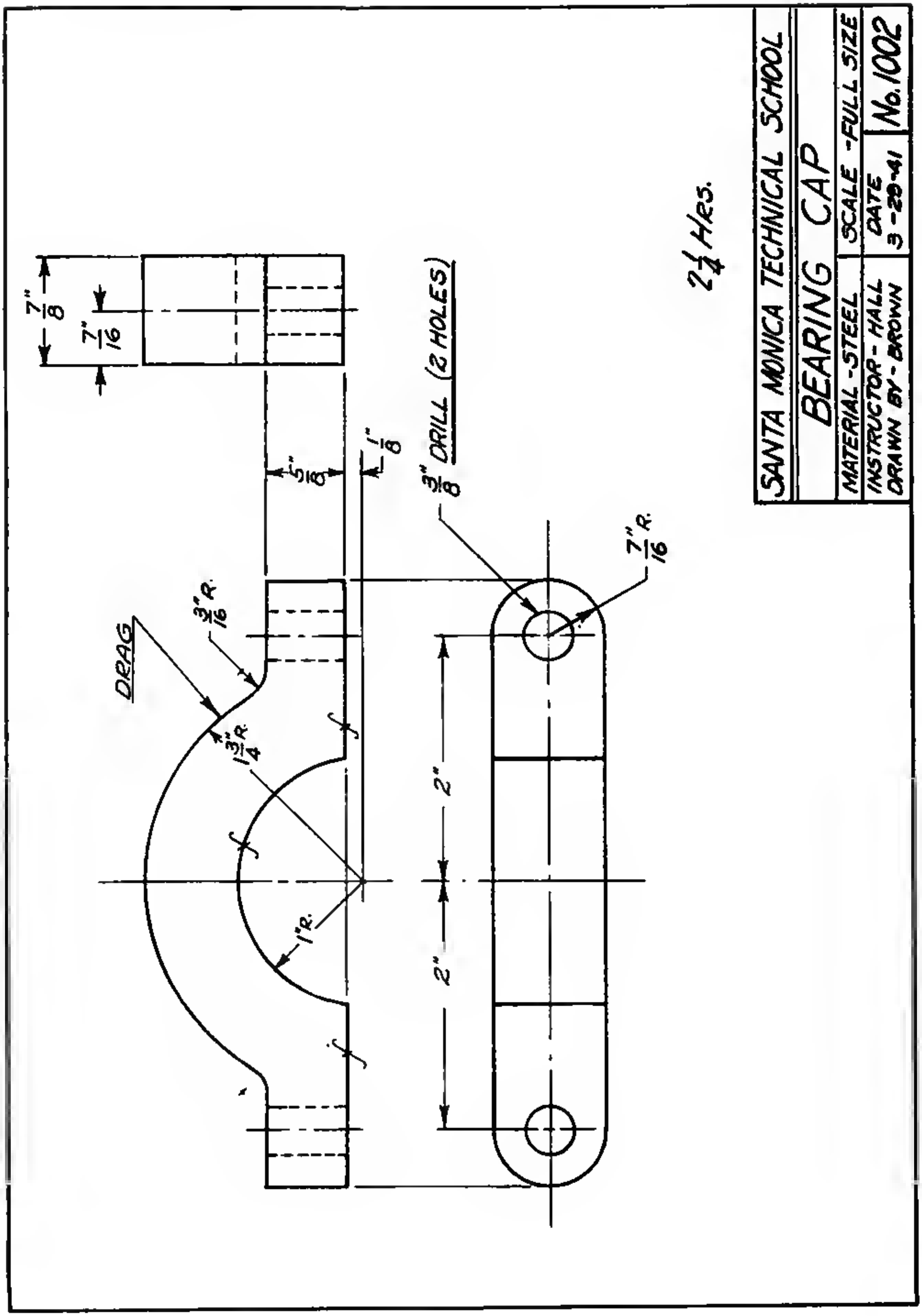
FIG. 106.—Operation 6. Sand riddled in cope.

FIG. 107.—Operation 7. Removing pattern.

FIG. 108.—Operation 8. Cope and drag ready to close.

FIG. 109.—Operation 9. Placing finished mold on floor.

FIG. 110.—Operation 10. Pouring.


SANTA MONICA TECHNICAL SCHOOL
BEARING CAP
MATERIAL - STEEL
SCALE - FULL SIZE
INSTRUCTOR - HALL
DRAWN BY - BROWN
DATE
No. 1002
2 1/4 HRS.
3/8" DRILL (2 HOLES)
DRAG
3/16" R.
1 3/4" R.
1" R.
7/16" R.
2"
2"
5/8"
1/8"
7/8"
7/16"

37. HOW TO USE TEMPLATES

Templates are used in many different ways by the patternmaker: to get perfect shapes in turnings and carvings; to assure even thickness of metal in core-box work, etc.

A template may be any shape desired and is usually made of thin stock. Many times, a pair or set must be made to get different shapes in different parts of the pattern, such as a cross section of the job would be. Outside-radius templates are used in nearly all jobs of medium size for rounding corners and ribs (see Fig. 111). Half-round templates are for core-box work, etc. (see Fig. 113). Templates other than for rounding corners and small core-box work should have a base or center line from which to check (see Fig. 112).

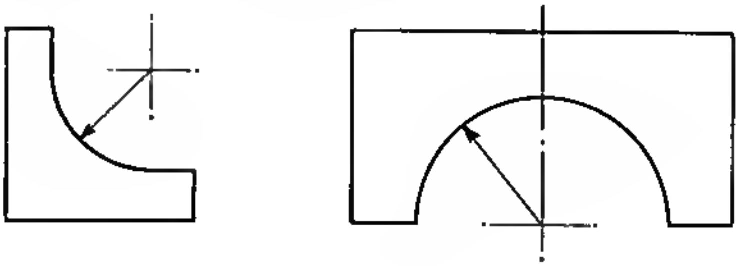


Fig. 111.

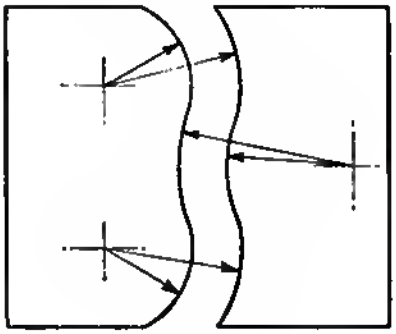


Fig. 112.

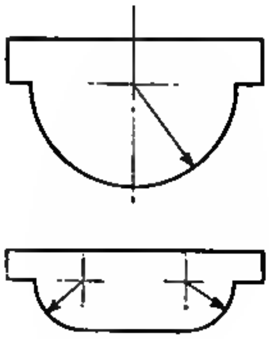


Fig. 113.

38. HOW TO LAY OUT AND CUT A TRUE ROUND OR BALL

1. Make layout of the size of round wanted with both center lines.
2. Mark in 45 deg. lines tangent to radius.
3. Take distance from center line to 45 deg. line, and transfer to the job to be rounded.
4. Cut the corners off on this 45 deg. line straight from one line to the other.
5. Make a template the size of the diameter, and cut off the points left on job to fit. Use crayon or chalk on inside of template to find the high places.

The following table shows the amount to cut off at corners for full round:

Radius, Inches	Amount to Be Cut Off, Inches
1/8	1/16
3/16	1/8
1/4	3/16
5/16	1/4
3/8	9/32
7/16	19/32
1/2	5/16
5/8	3/8
3/4	7/16
7/8	17/32
1	19/32
1 1/4	3/4
1 1/2	7/8
1 3/4	1
2	1 3/16
2 1/4	1 3/8
2 1/2	1 1/2
2 3/4	1 5/8
3	1 3/4

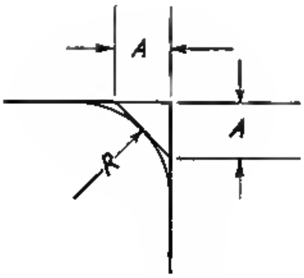
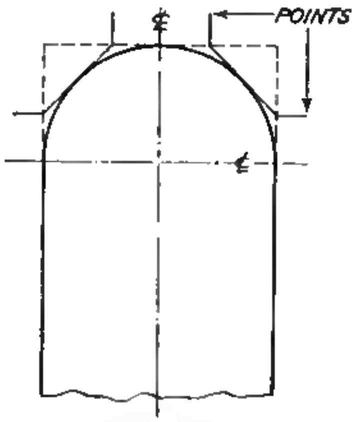
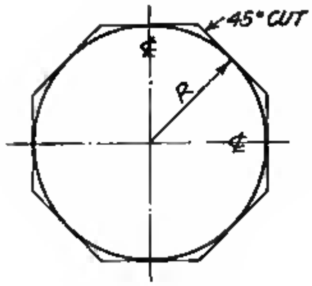


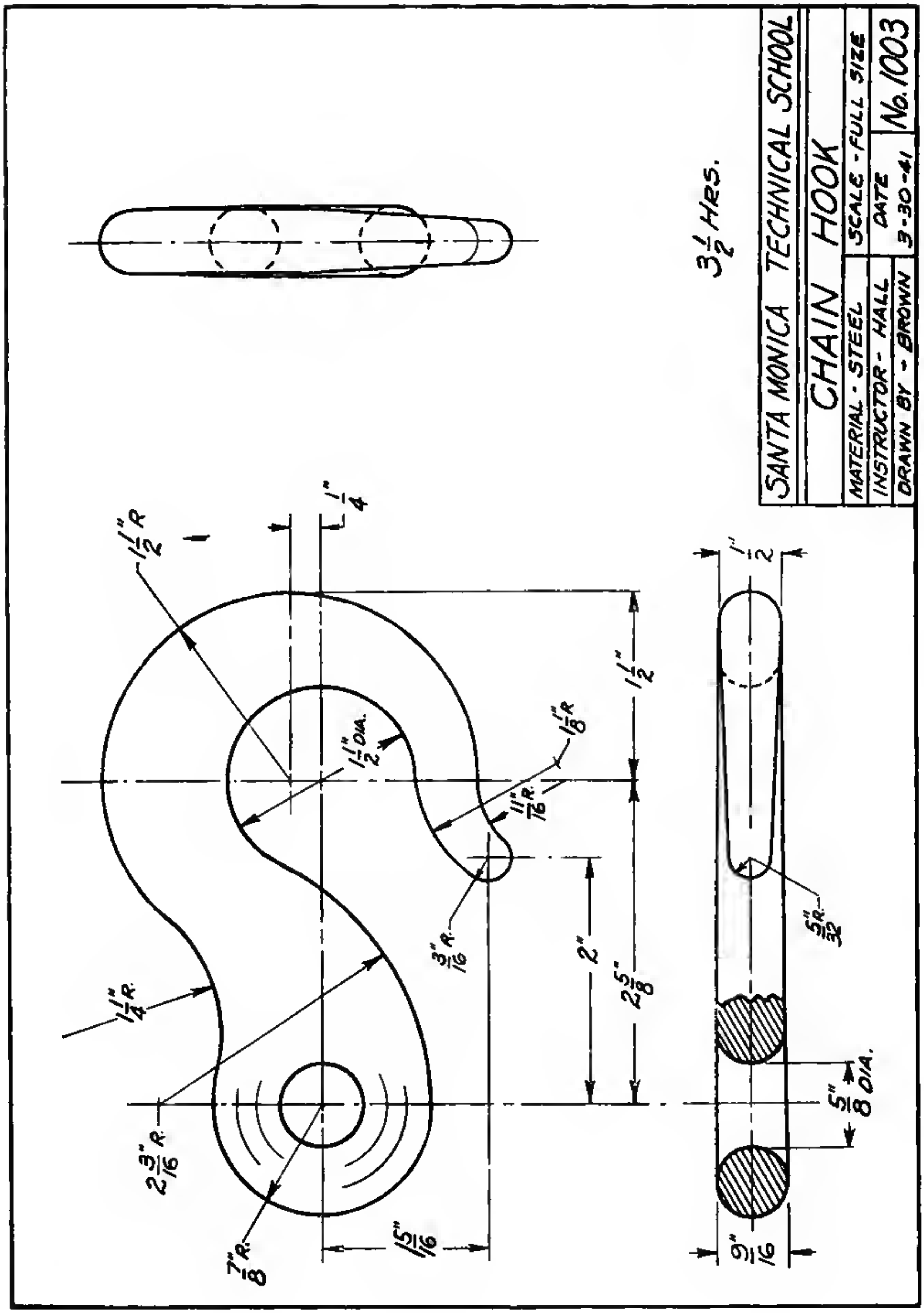
Fig. 114.



ROUNDED RIB
Fig. 115.



BALL
Fig. 116.


SANTA MONICA TECHNICAL SCHOOL
CHAIN HOOK
MATERIAL - STEEL
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 3-30-41
DRAWN BY - BROWN
No. 1003
3 1/2 HRS.

39. HOW TO PREPARE AND TURN STRAIGHT WORK

For this work a lathe, band saw, jointer, table saw, scale, calipers, dividers, turning tools, hammer, nail set, lumber, sandpaper, and oil are needed.

1. Get out stock at least 2 in. longer than actual length needed and ¼ in. larger than diameter wanted.
2. Find centers on the ends as in Fig. 117. Punch centers with nail set.
3. Put in lathe, and drive block into spur center with a hammer or mallet. Put a drop or two of oil on the cup center before starting to turn it.
4. Always use high speed for small work.
5. The tool rest should be set just below center of stock to be turned, as shown in Fig. 118.

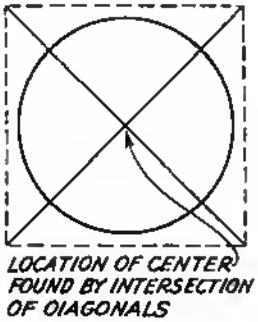


Fig. 117.

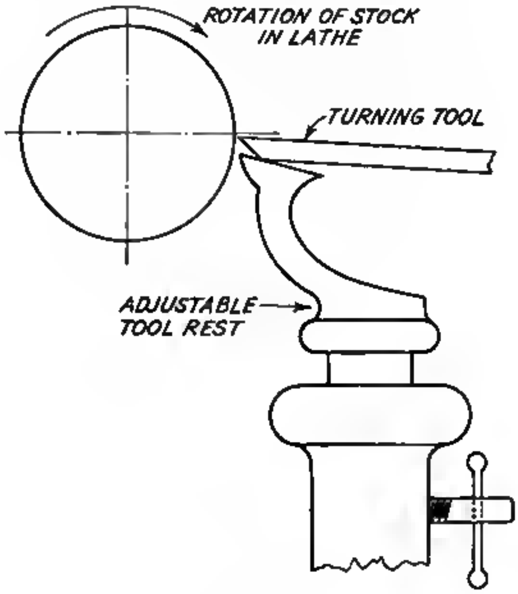
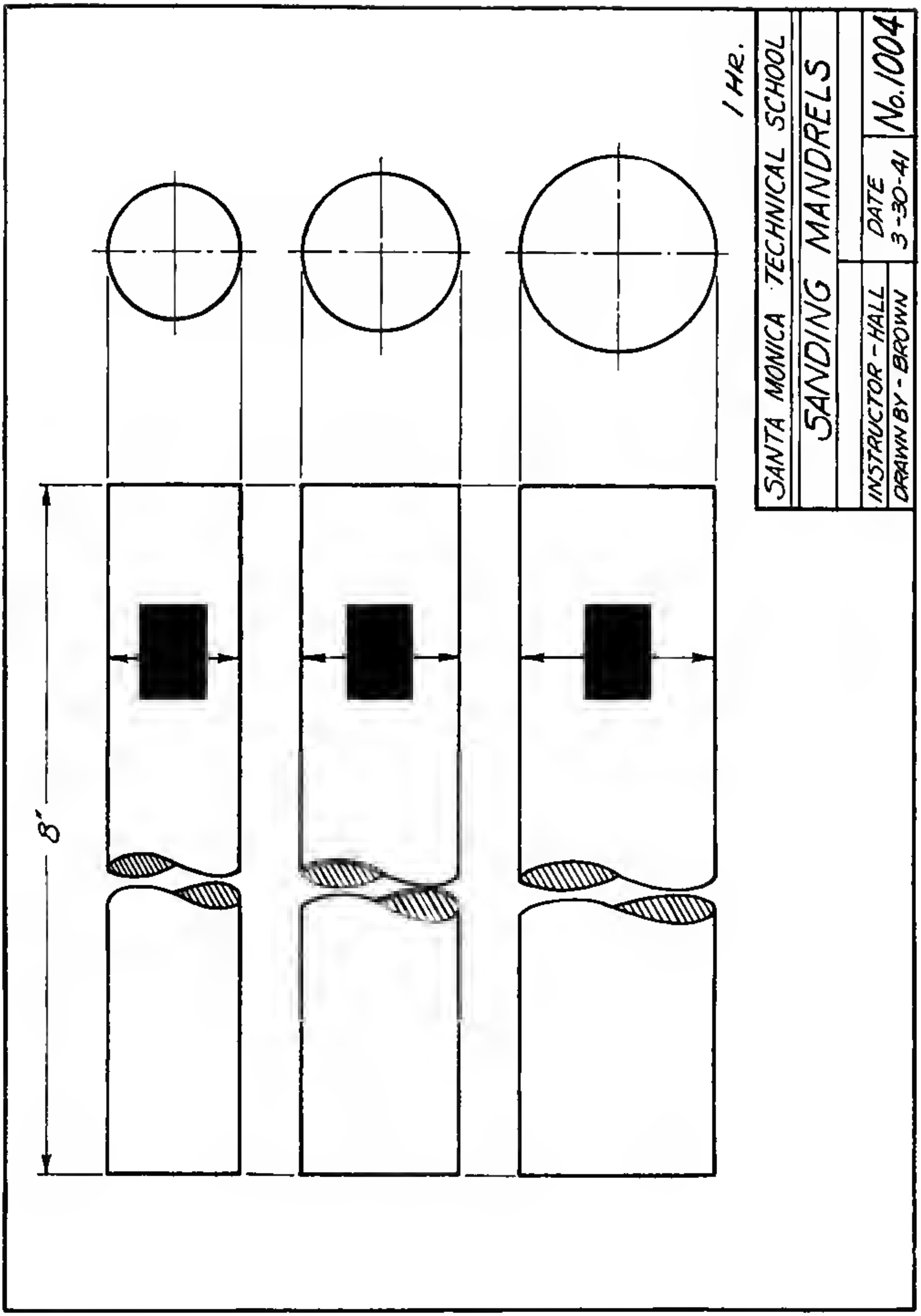
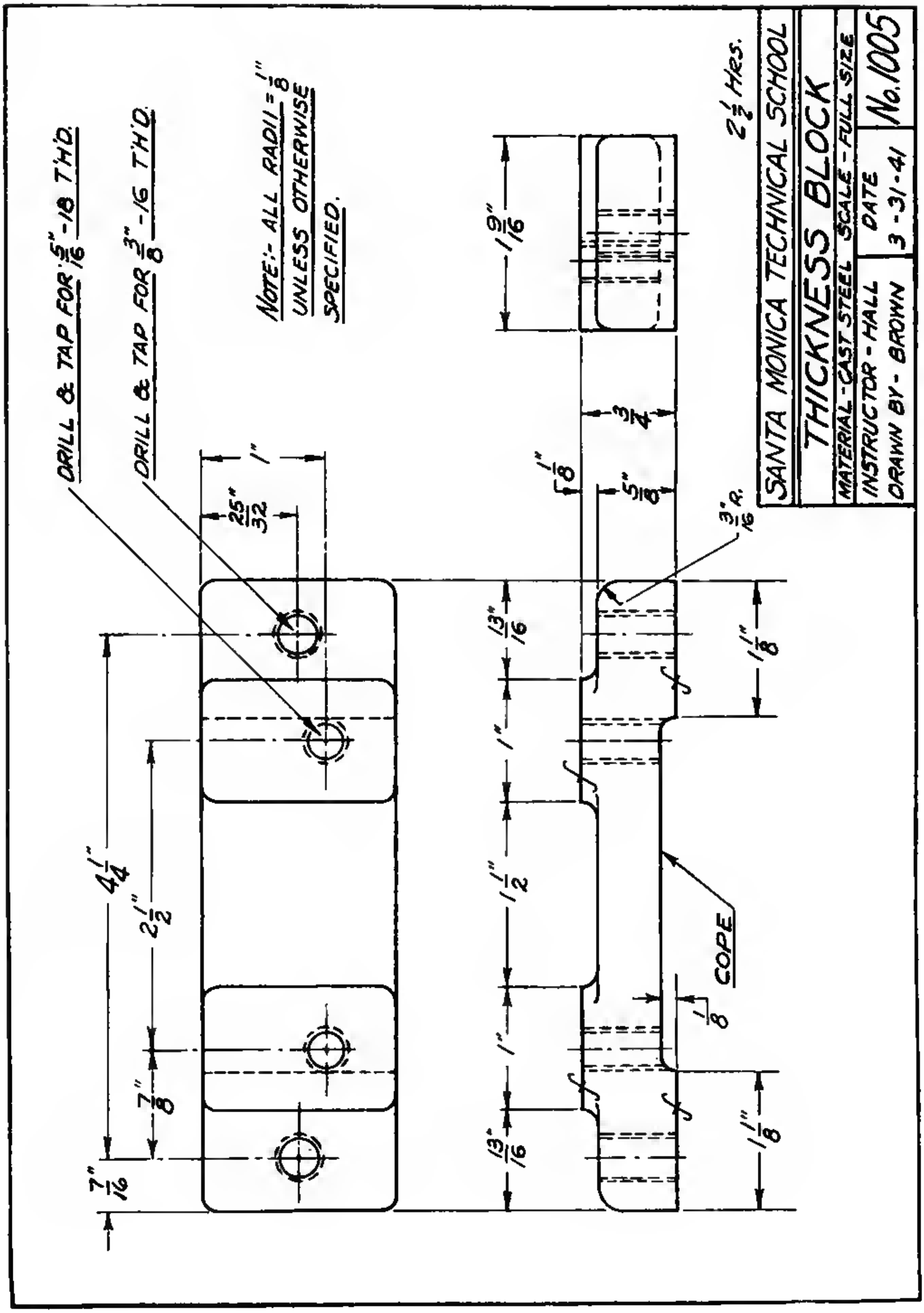
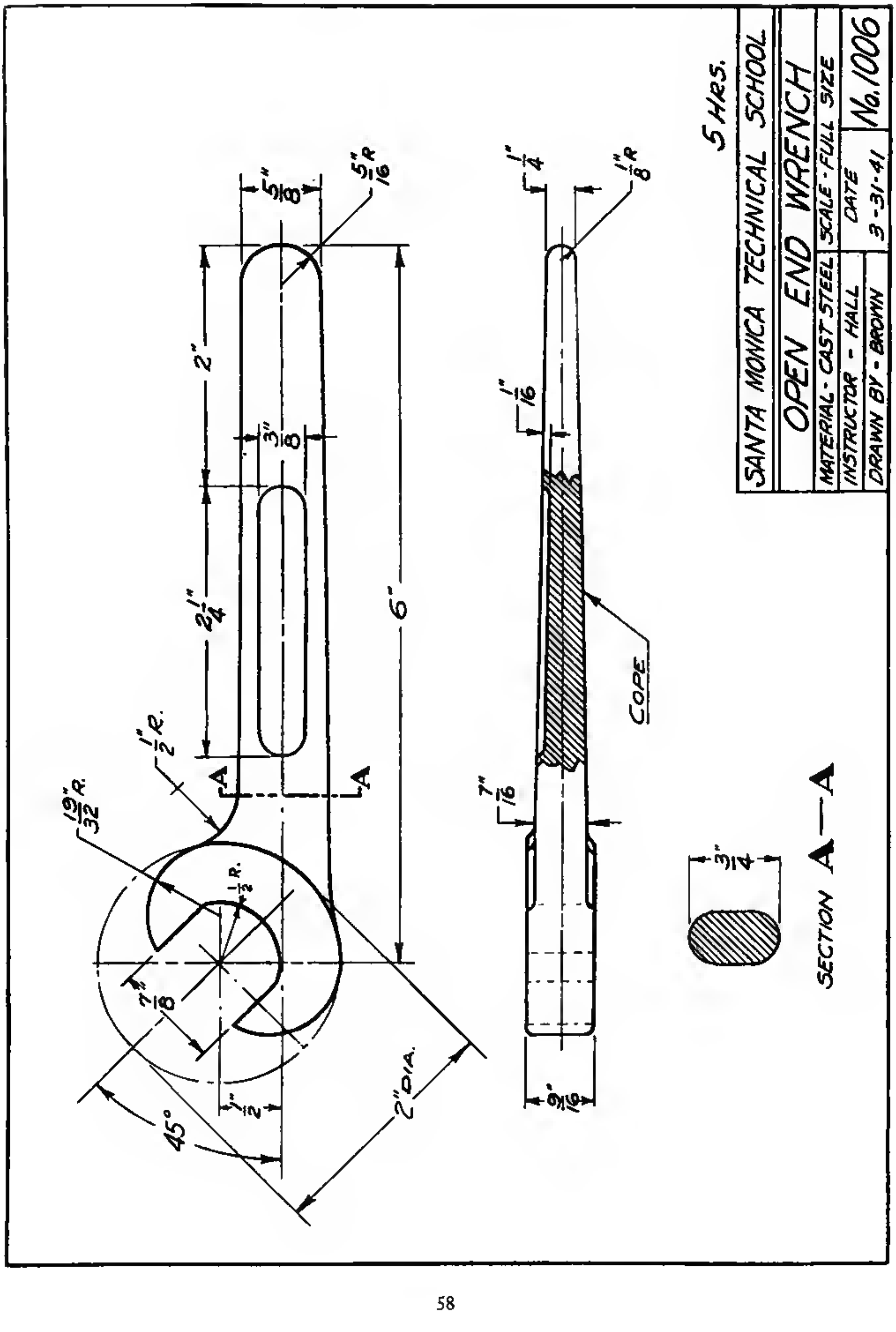


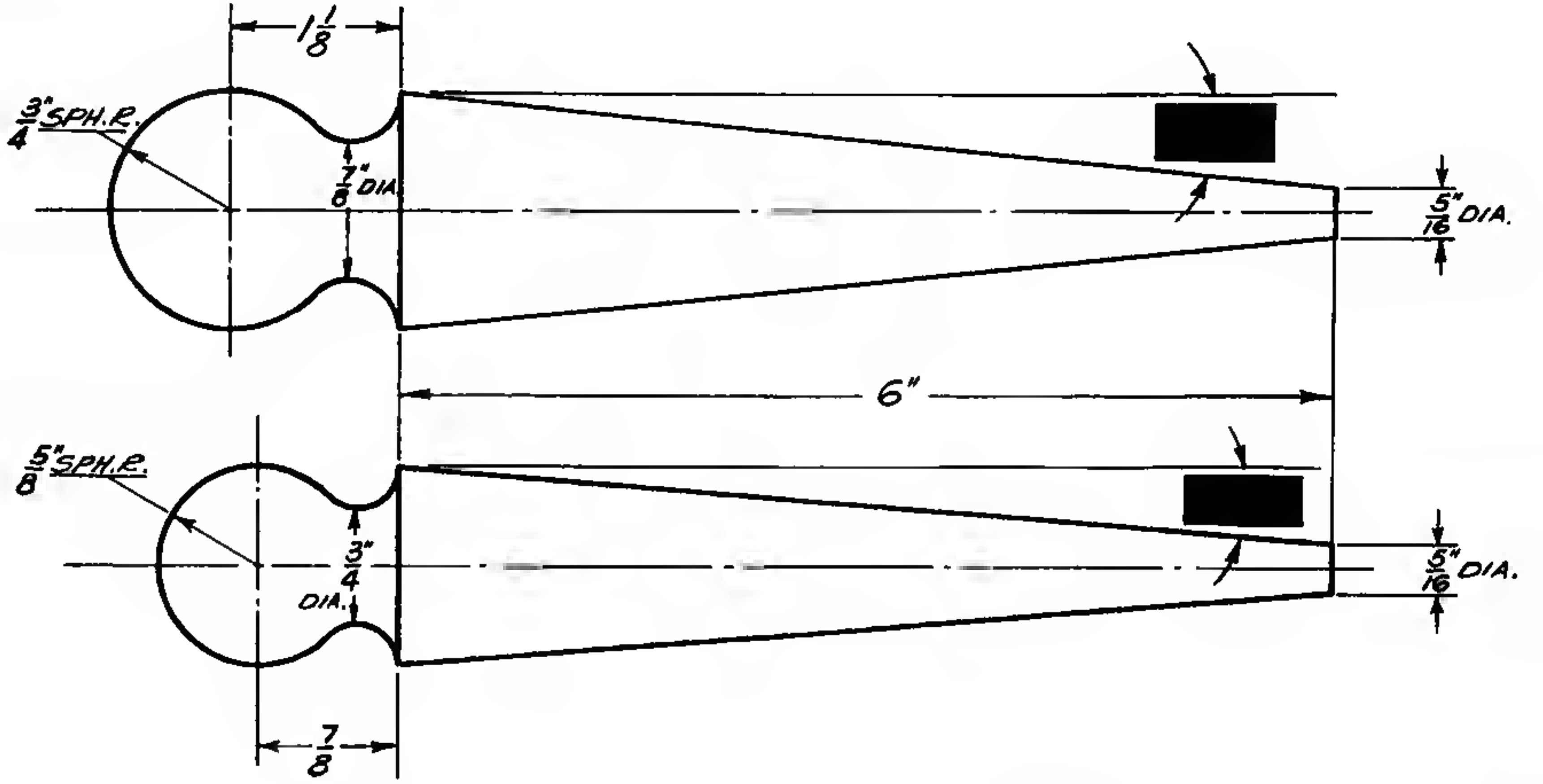
Fig. 118.



1 HR.
SANTA MONICA TECHNICAL SCHOOL
SANDING MANDRELS
INSTRUCTOR - HALL
DRAWN BY - BROWN
DATE
3-30-41
No. 1004
8"
[redacted]
[redacted]
[redacted]


DRILL & TAP FOR 5/16"-18 T'H'D.
DRILL & TAP FOR 3/8"-16 T'H'D.
NOTE:- ALL RADII = 1/8"
UNLESS OTHERWISE
SPECIFIED.
COPE
2 1/2 HRS.
SANTA MONICA TECHNICAL SCHOOL
THICKNESS BLOCK
MATERIAL - CAST STEEL
SCALE - FULL SIZE
INSTRUCTOR - HALL
DRAWN BY - BROWN
DATE
3-31-41
No. 1005

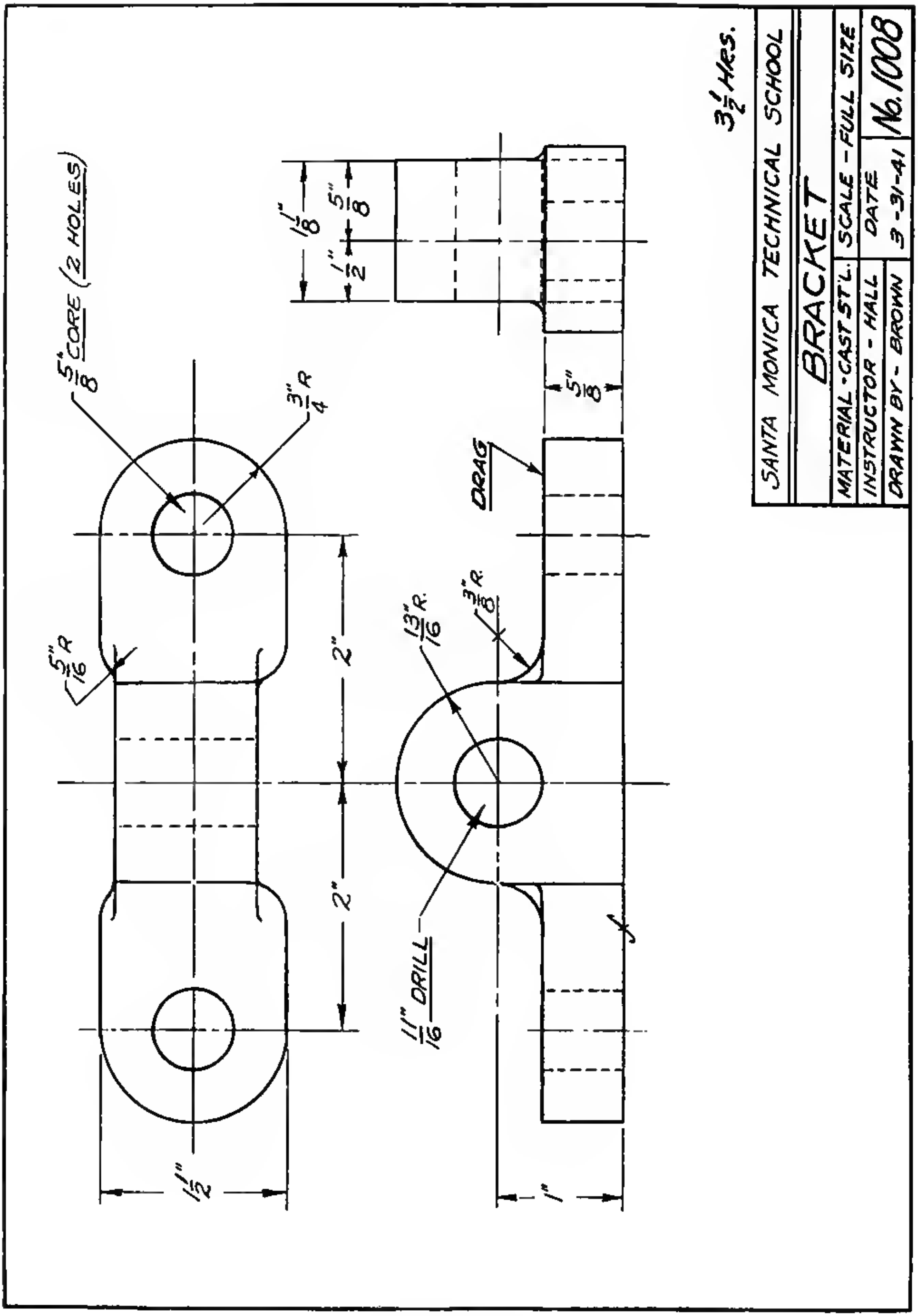

SANTA MONICA TECHNICAL SCHOOL
OPEN END WRENCH
MATERIAL - CAST STEEL
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 3-31-41
DRAWN BY - BROWN
No. 1006
5 HRS.
COPE
SECTION A—A
2" DIA.
45°
6"
2"
$2\frac{1}{4}$"
$\frac{5}{8}$"
$\frac{3}{8}$"
$\frac{5}{16}$" R
$\frac{1}{2}$" R.
$\frac{19}{32}$" R.
$\frac{7}{8}$"
$\frac{1}{2}$"
$\frac{1}{4}$"
$\frac{1}{8}$" R
$\frac{1}{16}$"
$\frac{7}{16}$"
$\frac{9}{16}$"
$\frac{3}{4}$"

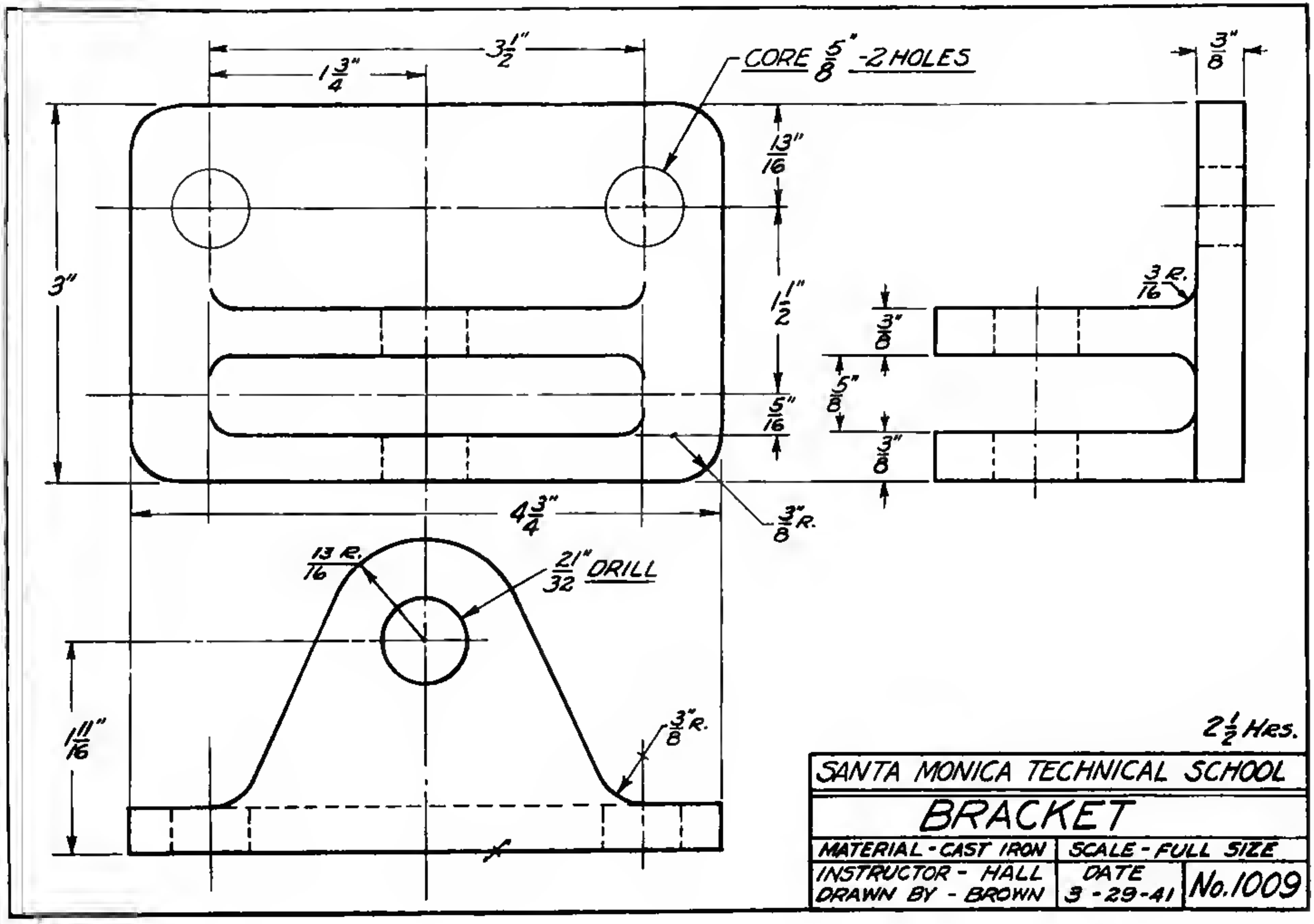


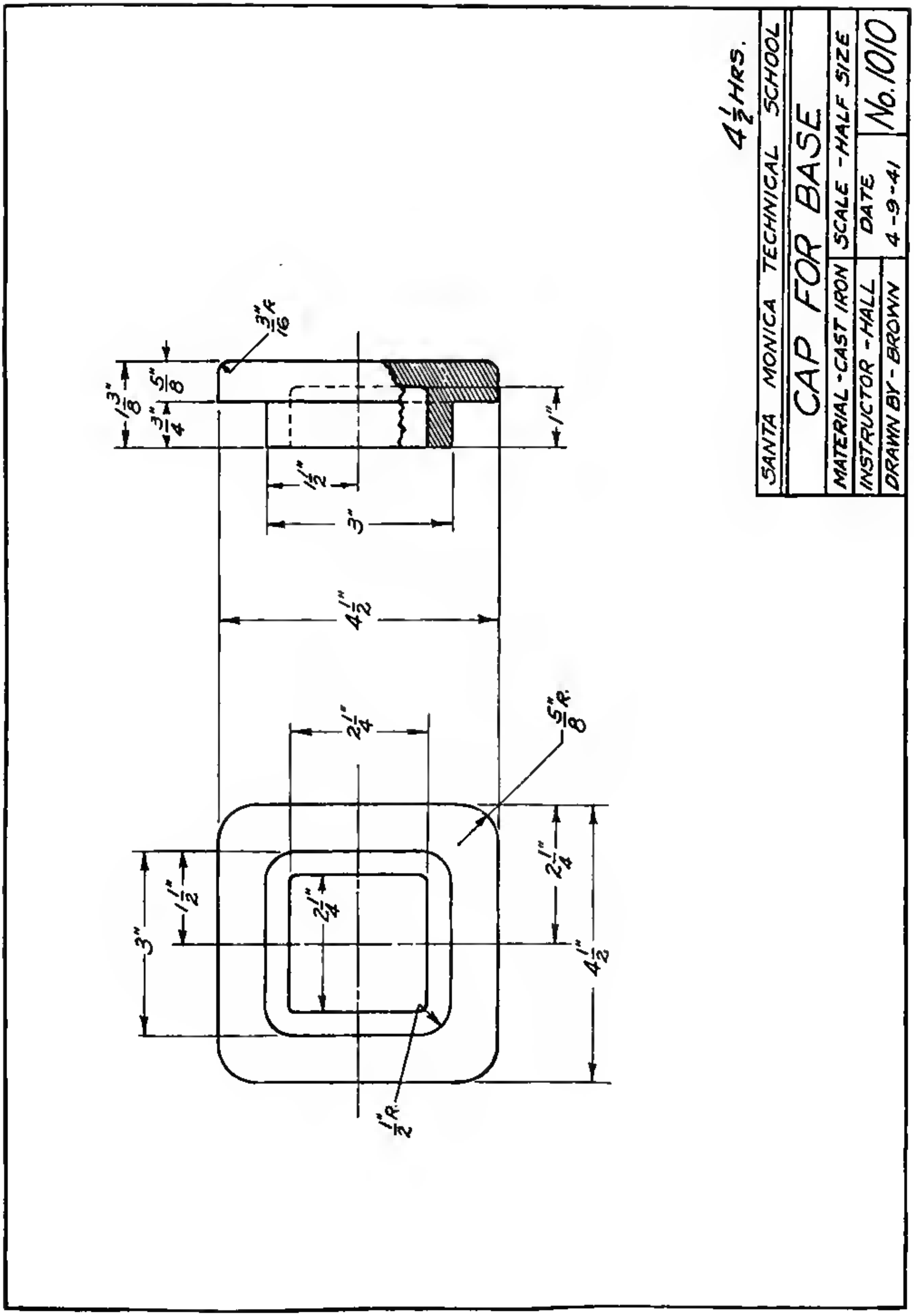
2 1/2 HRS.

MAKE LAYOUT

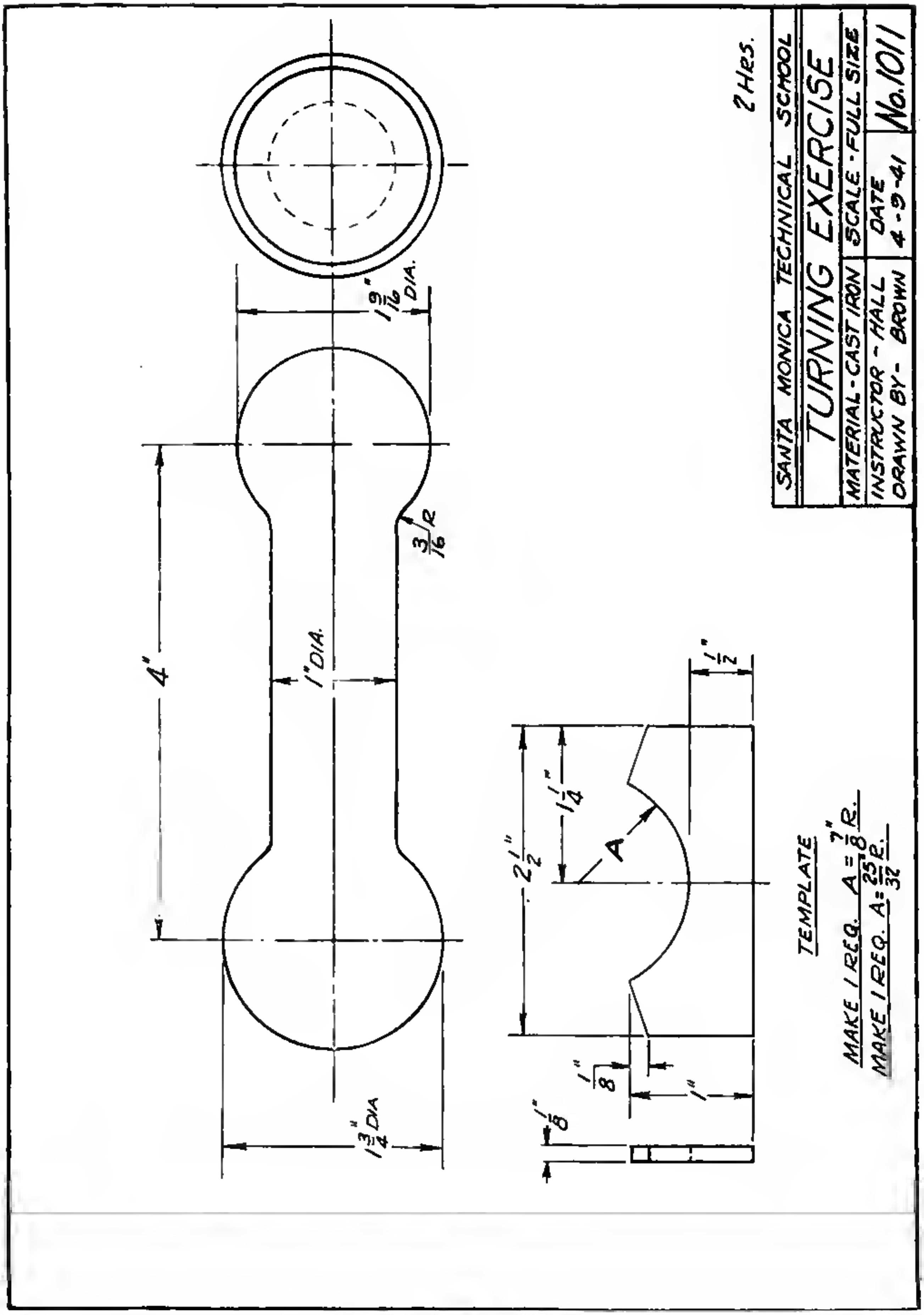
SANTA MONICA TECHNICAL SCHOOL		
TAPER SANDING MANDREL		
MATERIAL	SCALE	
INSTRUCTOR - HALL DRAWN BY - BROWN	DATE 3-28-41	No. 1007


SANTA MONICA TECHNICAL SCHOOL
BRACKET
MATERIAL - CAST ST'L.
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 3-31-41
DRAWN BY - BROWN
No. 1008
3½ HRS.
5/8" CORE (2 HOLES)
3/4" R
5/16" R
2"
2"
1½"
11/16" DRILL
13/16" R.
3/8" R.
DRAG
1"
5/8"
1⅛"
5/8"
1/2"


3 1/2"
1 3/4"
CORE 5/8" -2 HOLES
3/8"
3"
13/16"
1 1/2"
5/16"
3/16 R.
3/8"
5/8"
3/8"
4 3/4"
3/8" R.
13/16 R.
21/32" DRILL
1 11/16"
3/8" R.
2 1/2 HRS.
SANTA MONICA TECHNICAL SCHOOL
BRACKET
MATERIAL - CAST IRON
SCALE - FULL SIZE
INSTRUCTOR - HALL
DRAWN BY - BROWN
DATE
3-29-41
No. 1009



4½ HRS.
SANTA MONICA TECHNICAL SCHOOL
CAP FOR BASE
MATERIAL - CAST IRON
SCALE - HALF SIZE
INSTRUCTOR - HALL
DATE 4-9-41
DRAWN BY - BROWN
No. 1010


SANTA MONICA TECHNICAL SCHOOL
TURNING EXERCISE
MATERIAL-CAST IRON
SCALE-FULL SIZE
INSTRUCTOR - HALL
DRAWN BY- BROWN
DATE 4-9-41
No.1011
2 HRS.
1 9/16" DIA.
4"
1" DIA.
3/16 R
1 3/4" DIA
TEMPLATE
MAKE 1 REQ. A=7/8" R.
MAKE 1 REQ. A=25/32 R.
2 1/2"
1 1/4"
1/2"
A
1/8"
1"
1/8"

40. HOW TO PATCH A BROKEN MOLD

Many times a mold may be saved by patching a broken or a torn place. There are several reasons why molds are broken. There may be a rough place on the pattern, or there may not be sufficient draft. Breaking may be due to the carelessness of the molder in not lifting the cope straight off the drag or in scraping the sides while drawing the pattern itself out.

Torn molds usually occur in the cope, especially while molding solid patterns. This is a blind draw, and it is very difficult for the molder to make a clean mold unless there is enough draft for the pattern to release itself from the cope without being rapped. All solid patterns should have plenty of draft on the cope side.

If the mold is broken up too badly, a new one must be made. If the break is small, the molder may patch it by holding his trowel in the cavity left by the pattern and packing moist sand against it with a slick or spoon. In a bad break he may replace the pattern, fill in the missing sand, smooth the surface of the mold, and withdraw the pattern.

41. HOW TO DISTINGUISH COPE FROM DRAG

If a pattern is made symmetrical from the parting line, the cope and drag would be the same. If one side has higher ribs, bosses, or a projection of any kind, this should be the drag side. This is especially true if the pattern is to be made solid, as it is very difficult for the molder to cope in between ribs of any height or in a deep pocket without having plenty of draft. There is no way to rap the pattern in the cope and loosen it from the sand other than to use a vibrator, which is usually used only on plate or production work. All the molder can do is pick off the cope very carefully and hope for the best. If the cope breaks, he may be able to patch the mold and still use it. This patch may show in the casting, however, and would also take extra time for the molder.

In a split pattern, the cope half of the pattern may be rapped and lifted out of the cope the same as the drag half. Care should be taken in making a solid pattern to give plenty of draft on the cope side. In many cases the molder will use small sticks, known as *soldiers*. These soldiers are dipped into water so the sand will stick to them, and they are then rammed up in the cope. This method helps hold the suspended body of sand in the cope (Fig. 119). One or many of these soldiers may be used in a mold.

Gaggers are also used in the cope to aid in the lifting of larger bodies of sand. They are over four times as heavy as the sand itself, so care should be taken in placing them in the mold. Gaggers are usually placed close to the edge and to the cross bars in the cope. They are made of cast or wrought iron in an L shape as shown in (Fig. 121).

Figure 120 is a cross section of the cope and drag rammed up, showing gaggers.

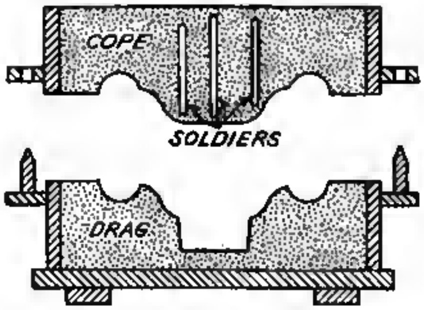


FIG. 119.

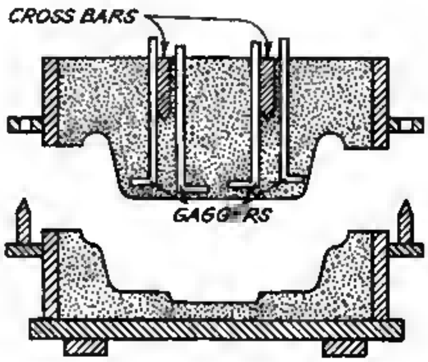
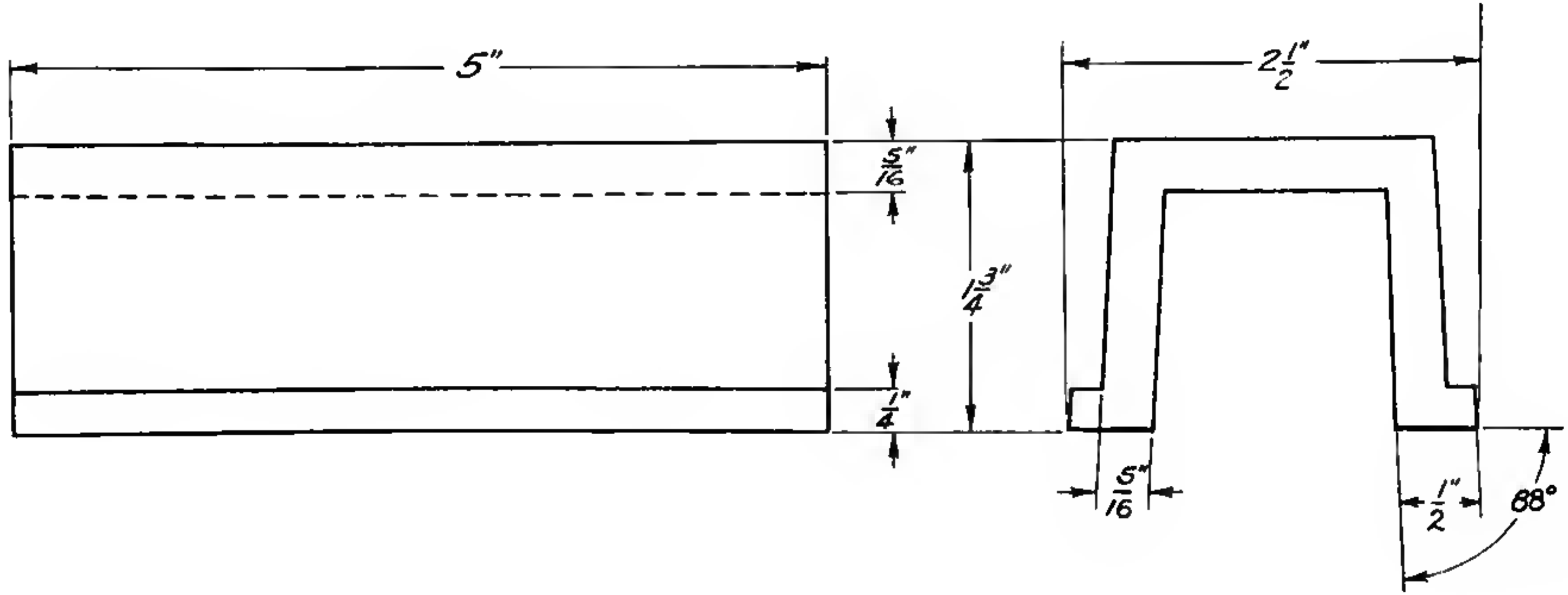


FIG. 120.

FIG. 121.



USE TABLE SAW

$\frac{3}{4}$ HR.

SANTA MONICA TECHNICAL SCHOOL		
TABLE SAW WORK - EXT'SN. BED		
MATERIAL - CAST IRON	SCALE - FULL SIZE	
INSTRUCTOR - HALL	DATE	No. 1012
DRAWN BY - BROWN	4 - 10 - 41	

42. HOW TO ESTIMATE THE COST OF PATTERNS

To estimate the cost of a pattern from the blueprint, one must break it down in parts or sections and then estimate each part of the pattern separately. For example, it will take about 4 hr. to lay it out, 2 hr. of lathe work, 3 hr. to build up the ribs on a certain section, 1 hr. to cut out the web, 1 hr. to cut out for a green sand core, 2 hr. to cut out or build up something on the other side of the job, etc. A core box or two may take 3 hr. sanding and shellacking, and the waxing would take 2 hr. The pattern should be checked before turning it over to the customer, and this could take another hour or two.

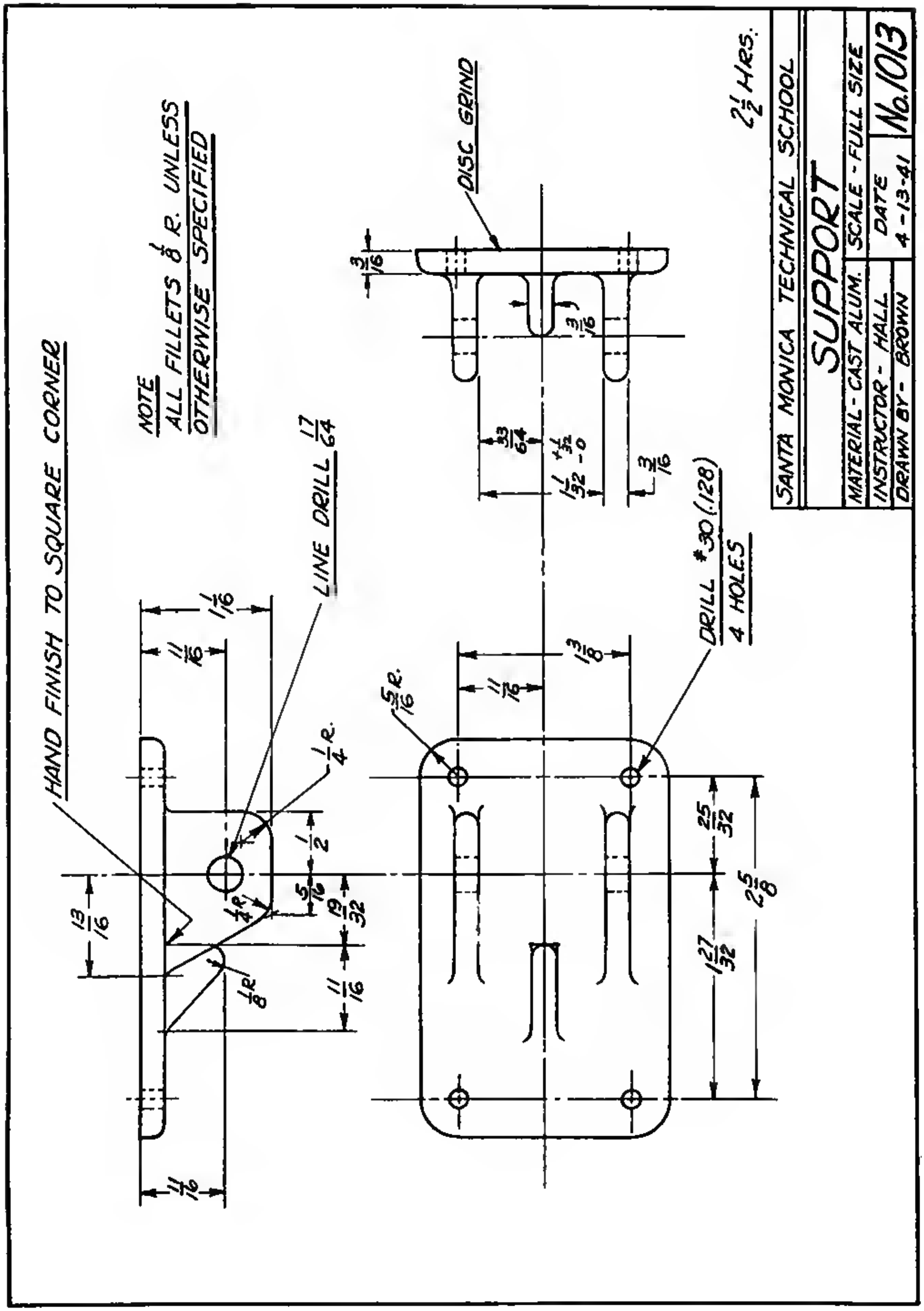
The estimated number of man-hours, or hours of labor on the pattern, is calculated at so much an hour. Figure the amount the patternmaker is to receive and to that add the cost of doing business and a profit. This gives the labor charge per hour to the customer.

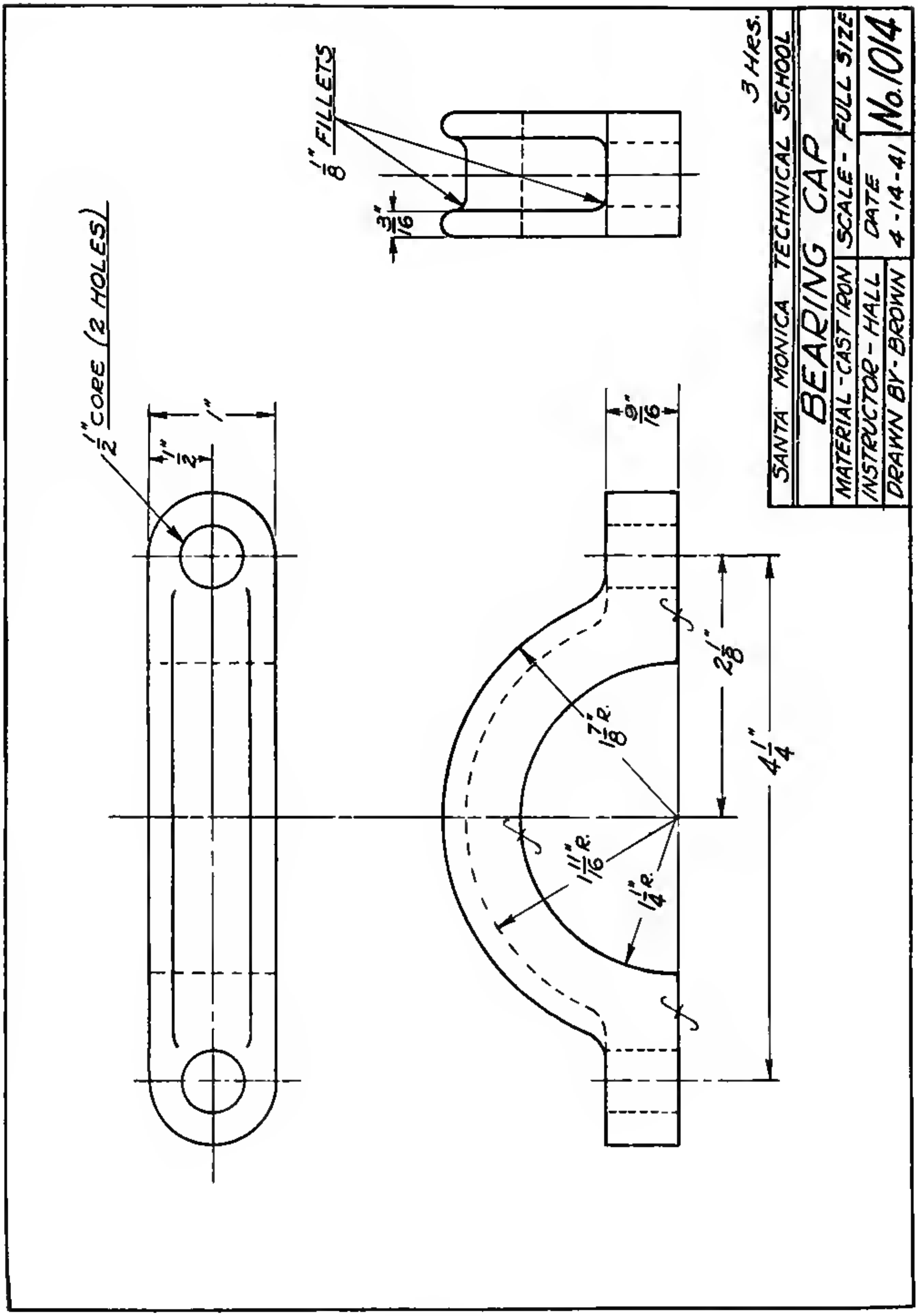
The cost of lumber, fillets, screws, rapping plates, etc., are figured on the cost of the pattern. This small pattern, with only 19 or 20 hr. of work for the patternmaker, may cost the customer $50 or $60, depending upon the amount of lumber, etc.

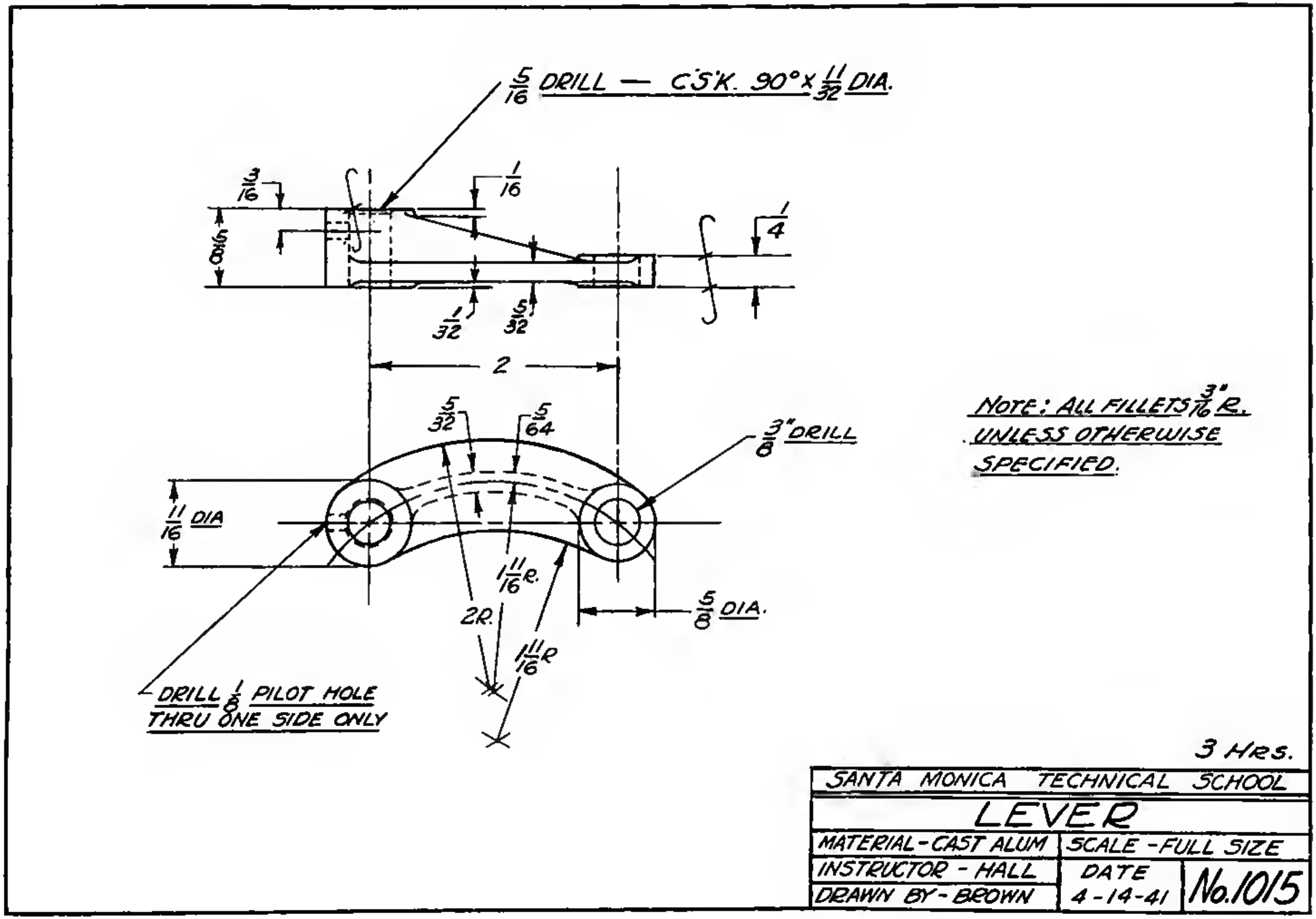
On every blueprint on which the patternmaker works in his training or school work, he should try to estimate the number of hours it would take to make the pattern. In time he can judge very closely the cost of a pattern by looking over the blueprint. Larger work takes more time to estimate, as one must know just how the pattern will be constructed in order to figure the amount of time for labor, etc. It may take days to get an estimate on some classes of pattern work.

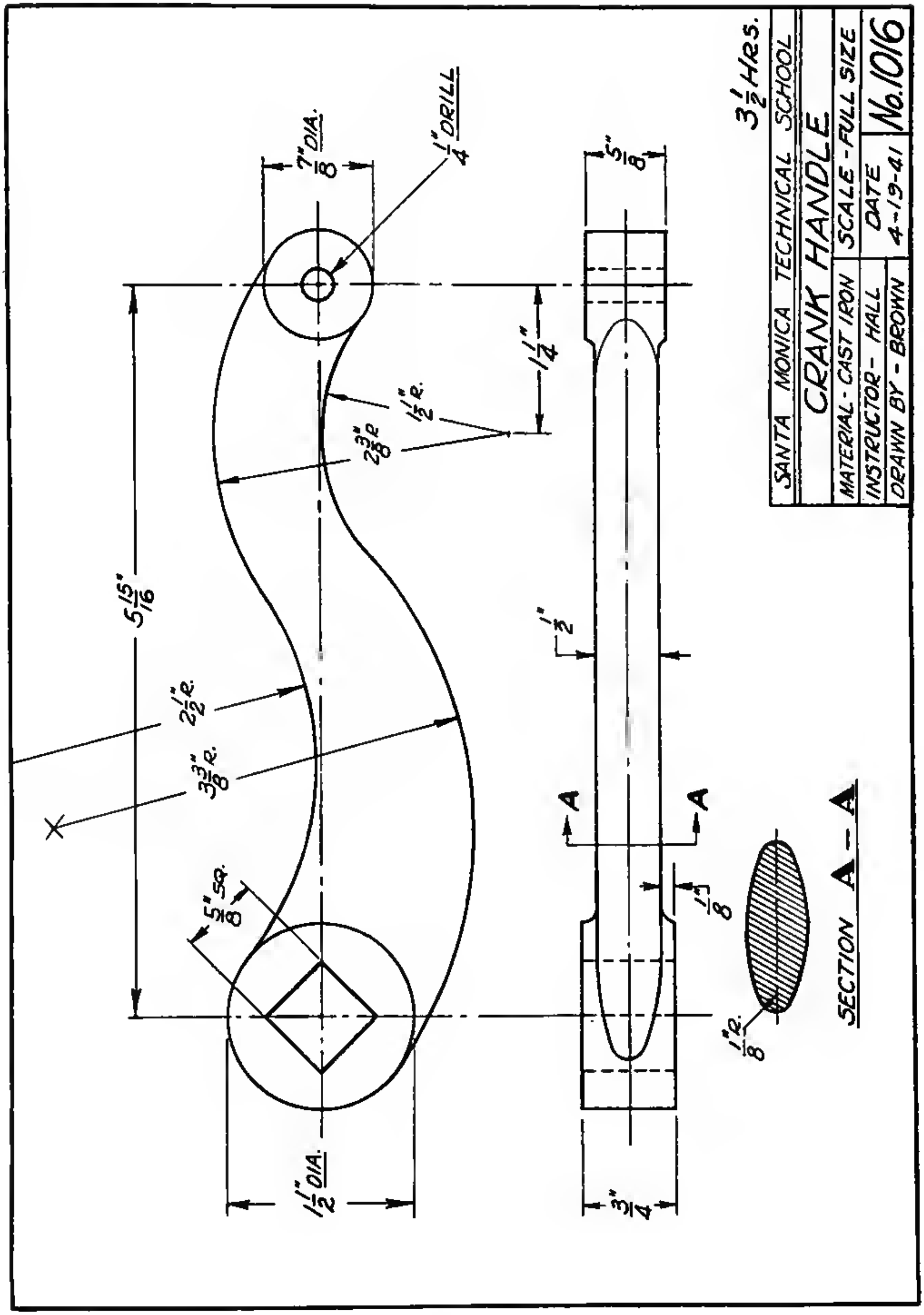
ESTIMATING SHEET

Operations	Hours estimated
1. Getting out stock, machining, gluing, etc	....
2. Making layouts	....
3. Building up	....
4. Lathe work as bosses, hubs, prints, etc	....
5. Ribs, flanges, cutouts, etc	....
6. Segment or stave work	....
7. Carving loose pieces	....
8. Core prints, core boxes	....
9. Rounding corners, leather fillets	....
10. Sanding, setting rapping plates	....
11. Shellacking and waxing	....
12. Checking	....
Total hours of labor	....
Number feet of mahogany	....
Number feet of pine	....
Number feet of leather fillet	....
Screws, nails, plates, glue, shellac, etc	....
Estimated cost of pattern	....


SANTA MONICA TECHNICAL SCHOOL
SUPPORT
MATERIAL - CAST ALUM.
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 4-13-41
DRAWN BY - BROWN
No.1013
2½ HRS.
NOTE
ALL FILLETS 1/8 R. UNLESS OTHERWISE SPECIFIED
HAND FINISH TO SQUARE CORNER
LINE DRILL 17/64
DISC GRIND
DRILL #30 (.128)
4 HOLES


SANTA MONICA TECHNICAL SCHOOL
BEARING CAP
MATERIAL - CAST IRON
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 4-14-41
DRAWN BY - BROWN
No. 1014
3 HRS.
1/8" FILLETS
1/2" CORE (2 HOLES)
1"
1/2"
3/16"
9/16"
2 1/8"
4 1/4"
1 7/8" R.
1 11/16" R.
1 1/4" R.


5/16 DRILL — C'S'K. 90° x 11/32 DIA.
3/16
5/8
1/16
1/4
1/32
5/32
2
5/32
5/64
3/8" DRILL
NOTE: ALL FILLETS 3/16" R. UNLESS OTHERWISE SPECIFIED.
11/16 DIA
1 11/16 R.
2R.
1 11/16 R
5/8 DIA.
DRILL 1/8 PILOT HOLE THRU ONE SIDE ONLY
3 HRS.
SANTA MONICA TECHNICAL SCHOOL
LEVER
MATERIAL - CAST ALUM
SCALE - FULL SIZE
INSTRUCTOR - HALL
DRAWN BY - BROWN
DATE 4-14-41
No. 1015


3 1/2 HRS.
SANTA MONICA TECHNICAL SCHOOL
CRANK HANDLE
MATERIAL - CAST IRON
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 4-19-41
DRAWN BY - BROWN
No.1016
7/8" DIA.
1/4" DRILL
5/8"
1 1/4"
1/2" R.
2 3/8" R
5 15/16"
1/2"
2 1/2" R.
3 3/8" R.
A
A
5/8" SQ.
1/8"
1/8" R.
SECTION A - A
1 1/2" DIA.
3/4"

43. HOW TO MAKE CORES

Core making deals with the construction of separate shapes made of sand. These cores form holes, cavities, or pockets in the casting. Cores are made of a different composition from regular molding sand. The sand is mixed with linseed oil or a manufactured core oil as a binder. Fifty parts sand to one part oil makes a good strong core. This mixed sand is shaped in molds known as *core boxes* and dumped out on a core plate, which is a flat cast-iron plate made for this use. It is then baked in a core oven, the length of time depending upon the size of the core.

Heavy cores have a reinforcing rod rammed up in the inside so they may be lifted and placed in the mold with lifting hooks. Coke is sometimes used on the inside of large cores so the gas may pass through while the mold is being poured. This is called *venting*.

Crooked cores or cores that have rounded corners or edges, or no flat surface to lie on, are made with the help of a bedding-in frame. This is a box frame or box that slips over the outside of the regular core box. The core is rammed up in the regular way. Then the top half of the core box is lifted off. The frame is then slipped over the bottom half of the core box which contains the core.

This frame is filled with molding sand and the top struck off. A core plate is laid on, and it is turned over. Then the other half of the core box is lifted off. Lastly, the frame is slipped off the top and the core is left lying on a bed of sand ready for the oven.

In production work where many cores will be made, a core drier would be used. Usually it is made of cast iron. As one half of the core box is taken off, this drier is slipped on and turned over, leaving the core lying in this drier. It is then put into the core oven.

Fig. 122.—Making a core from a core box.

44. HOW TO CONSTRUCT VARIOUS TYPES OF CORE BOXES

There are an unlimited number of shapes, sizes, and types of core boxes. Many types are constructed much the same as to shape and how the grain of the wood should run, etc. A production core box or a box from which many cores will be made should be made very substantial and well glued and nailed. The larger ones should be screwed together and well braced as they must withstand very rough usage in the core room. The core oil will penetrate the box and loosen the glue if it is not well shellacked on the outside as well as on the inside. The constant rapping on the box to get cores out will rack many well-built boxes in a short time.

Figure 123 is called a chambered box with the grain running lengthwise. It is made up in sections with cross grain on the ends. All parts should be glued and nailed. A solid piece should run across the bottom to tie all the sections together, and there should also be a strip on each side if a great number of cores are to be made from this box. Hit all edges and corners on sander about 45 deg.

Figure 124 is a cone box. The ends, or many times only one end, will have a cone for the cope print. Boxes of this type are built much the same as the chambered box.

A box (Fig. 125) that will take thicker stock than that on hand will have to be glued, and material will be saved in laying it up as in the sketch on the opposite page. The grain should run lengthwise with cross grain on the ends. Glue and nail well.

Small boxes for square or round cores (Fig. 126) should be split. Put in two dowel pins. Have grain running crosswise and the box open on both ends so that the core maker can fill it from the top. Draw the box away from the core, leaving the core standing on end on the core plate.

The pinless box (Fig. 127), known as the Chicago core box, is suitable only if few cores will be made as one casting job. Get out stock of the thickness needed. Band saw an irregular line across so the box will fit; then cut core hole through, as shown on the illustration.

A wing box (Fig. 128) is usually made up of two or more pieces and may be split on the center, or as in the sketch following. Dowel pins should be used. This type of box is filled at the top, then turned over and the box pulled apart, leaving core on plate.

A gang box (Fig. 129) is for making more than one core at a time. Usually only small cores are made in this type of box. Metal boxes are commonly used in production core work.

A dump box (Fig. 130) may be solid and have loose ends, sides, or bottom. This type is usually filled from the top, then turned over on a plate and the box lifted off, leaving the core on the plate.

CONSTRUCTION OF CORE BOXES

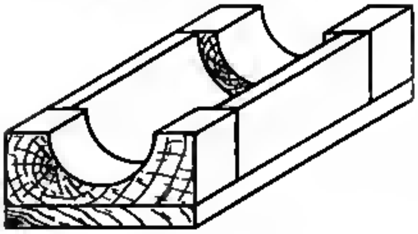


Fig. 123.

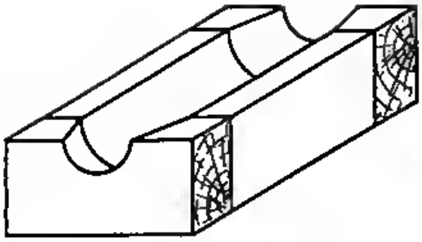


Fig. 124.

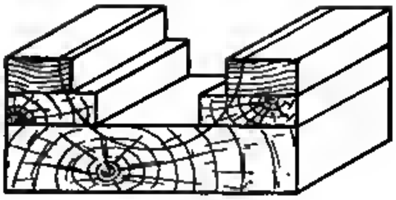


Fig. 125.

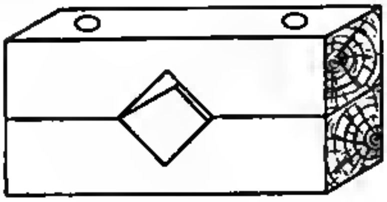


Fig. 126.

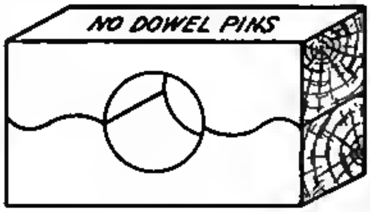


Fig. 127.

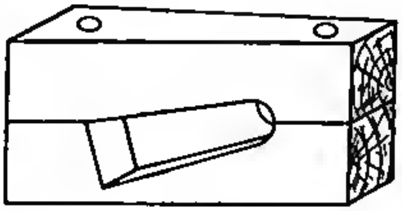


Fig. 128.

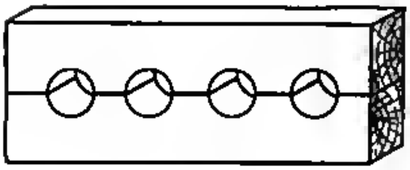


Fig. 129.

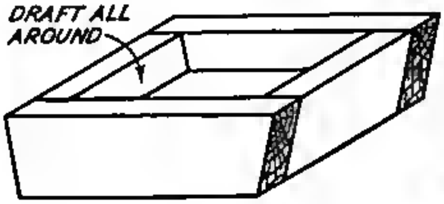


Fig. 130.

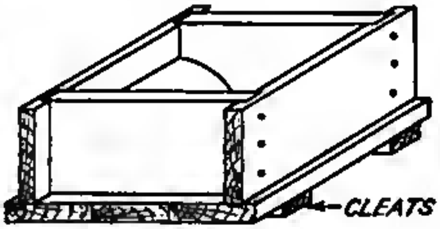


Fig. 131.

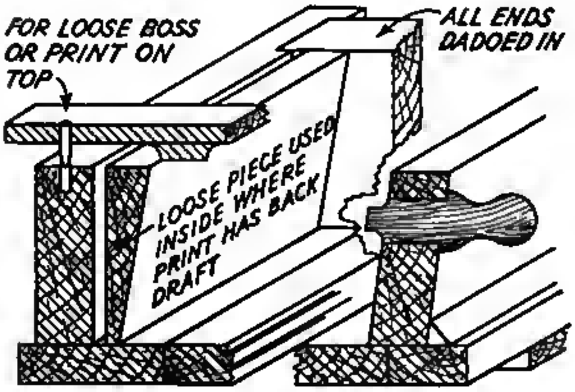


Fig. 132.

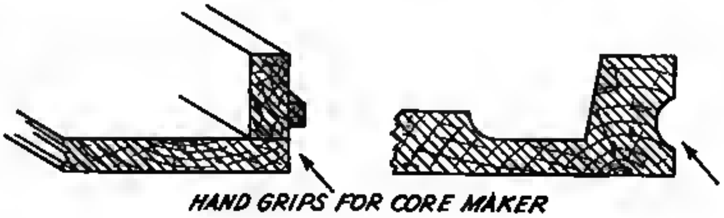


Fig. 133.

46. HOW TO PREPARE STOCK AND USE A CORE-BOX PLANE

In this work a band saw, table saw, jointer, sander, scale, dividers, square, knife, gage, core-box plane, sanding mandrel, gouge, lumber, and sandpaper are used.

1. Get out stock the length wanted.
2. Gage center lines on the face and both ends.
3. Scribe the radius and diameter of the core wanted on each end.
4. Scribe another radius ⅛ in. smaller on each end for saw cut limits.
5. Set table saw to cut 1/16 in. deep. Cut to the edge of the larger radius on each side, being careful of the working edge.
6. Cut slots through the stock with the table saw up to the first radius line, leaving the ⅛ in. for the plane to cut.
7. Rough out to the first radius line with a gouge.
8. Put stock in the vise, and plane it from the right side to the center; reverse the stock in the vise, and start from the right and work to the center again.
9. Get sandpaper mandrel at least 1/16 in. smaller than the size of core wanted. Sand with about No. ½ sandpaper until smooth.

Have no less than ¾ in. on the face of the box for wearing surface.

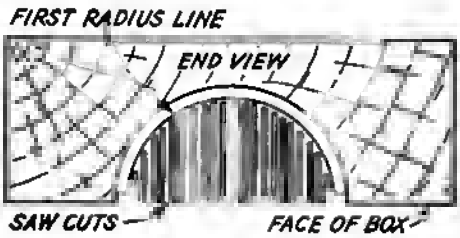


FIG. 134.

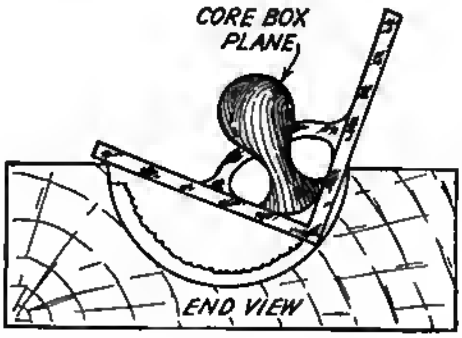


FIG. 135.

46. HOW TO MAKE CASTING FROM DRAWING OR BLUEPRINT

The shape and sizes of the casting are all that the blueprint will show. It will not show where to split the pattern, or if it is split, or how to core it out. This is left to the judgment of the patternmaker.

Figure 136 is a drawing of the casting wanted. Figure 137 is the finished pattern, with core prints which are made the diameter of the hole wanted, and long enough to support the core. The pattern is split for greater speed and convenience to the molder. The dowel pins are to hold the split pattern in place.

Figure 139 shows the type of core box commonly used to make the core that is placed in the mold to form the hole. It should be the diameter of the prints and as long as the total length of the pattern and core prints.

Figure 138 shows the two half cores taken out of the core box. They will be baked in a core oven and pasted together before being placed in the mold. Figure 140 shows the casting taken off the pattern.

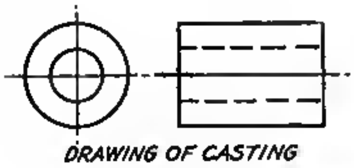


Fig. 136.

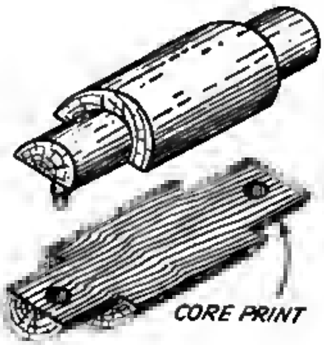


Fig. 137.

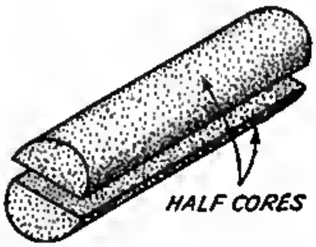


Fig. 138.

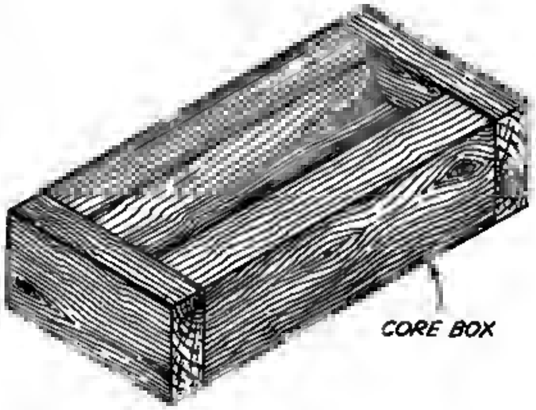


Fig. 139.

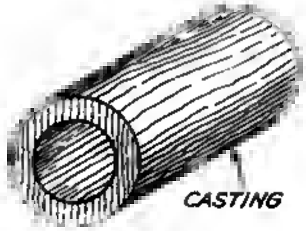


Fig. 140.

47. HOW TO PREPARE SPLIT STOCK FOR TURNING

For this work a band saw, jointer, table saw, drill press, plane, scale, bit, hammer, 1/8-in. drill, lumber, corrugated nails, and dowel pins are needed.

1. Get out two pieces of stock for the two halves of the pattern.
2. The stock should be at least 2 in. longer than the actual length wanted. This extra length is for the lathe centers and corrugated nails.
3. The stock should be at least 1/4 in. larger than the diameter wanted. This extra size is to allow for turning down in the lathe.
4. The two pieces of stock are held together in a vise. Drive two corrugated nails in each end about 1/2 in. from center (as shown in Fig. 141).
5. Drill dowel-pin holes the size wanted in the best location for the job.
6. If wood dowels are used, sharpen them on the sander before inserting. Do not glue dowel pins in at this time.
7. Drill a 1/8-in. hole in each end about 3/8 in. deep for the lathe centers. Be sure this hole is in the center both ways (as shown in Fig. 141).

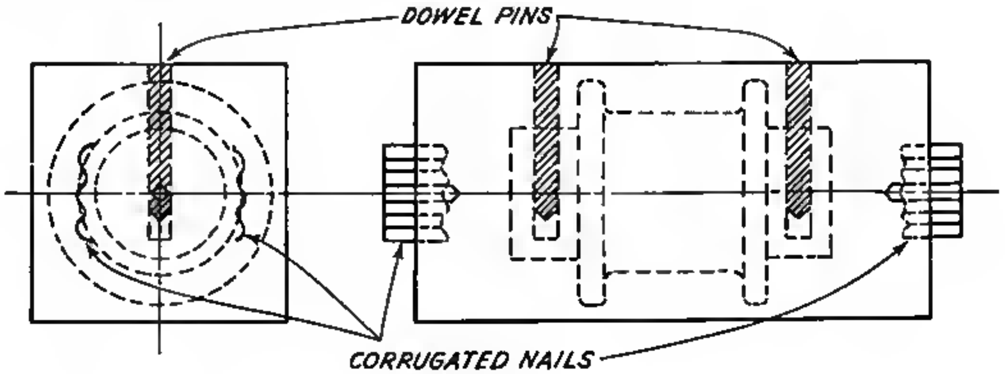
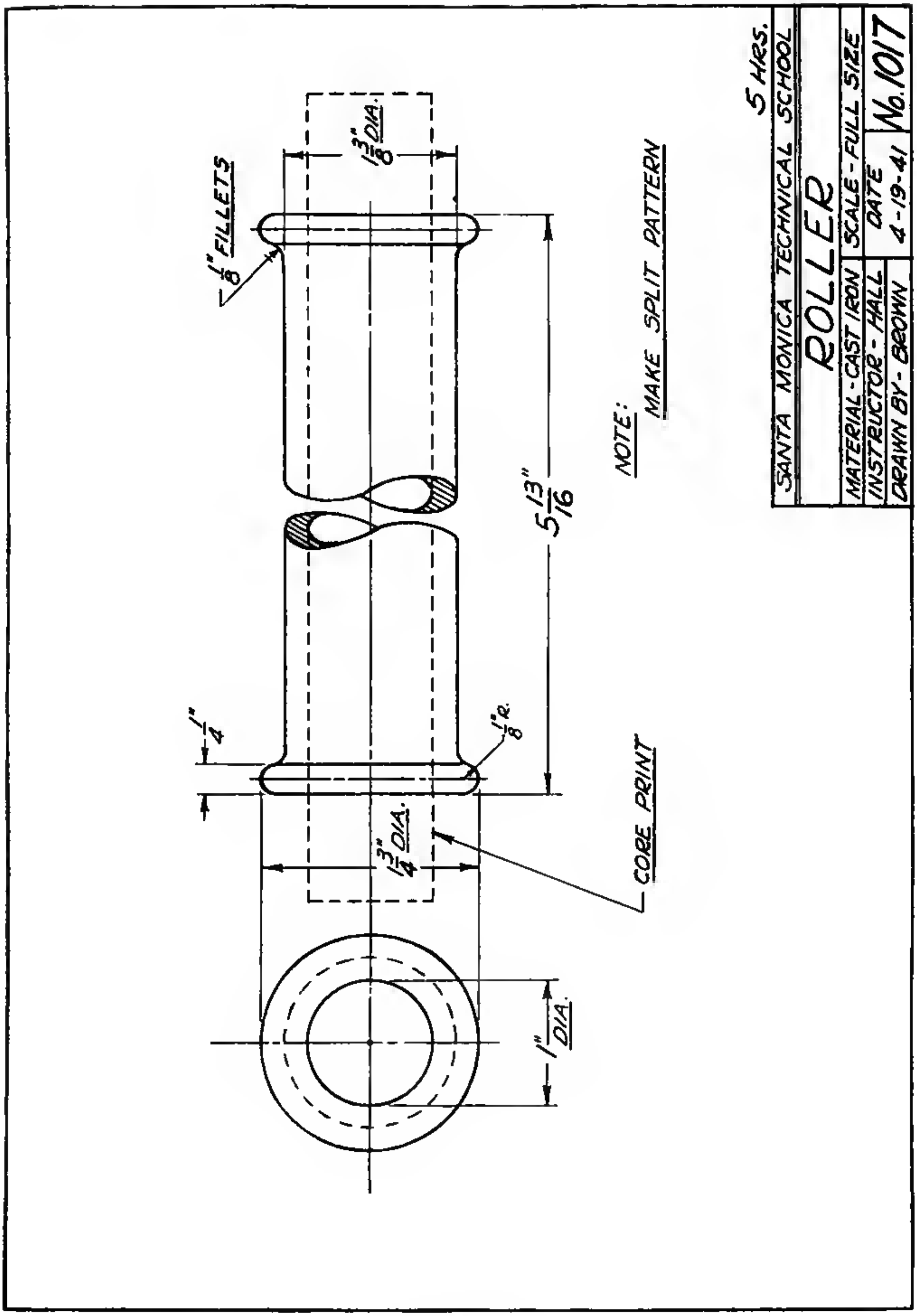
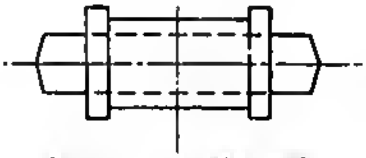


Fig. 141.


5 HRS.
SANTA MONICA TECHNICAL SCHOOL
ROLLER
MATERIAL - CAST IRON
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 4-19-41
DRAWN BY - BROWN
No. 1017
NOTE: MAKE SPLIT PATTERN
CORE PRINT
1/8" FILLETS
1 3/8" DIA.
1 3/4" DIA.
1" DIA.
5 13/16"
1/4"
1/8" R.

48. HOW TO MOLD SPLIT PATTERNS WITH DRY SAND CORE

1. Lay the drag half of pattern on the bottom board.
2. Dust it with parting sand, and set the drag on bottom board (with pins down.
3. Riddle sand first to cover bottom, then fill it up and ram.
4. Strike off as in Fig. 142. Turn it over and put on cope half of pattern. Replace cope. set sprue and riser pins, and dust.
5. Ram up cope as shown in Fig. 143, strike off, pull pins, and round holes.
6. Pick off the cope and draw pattern from both cope and drag.
7. Cut gates, clean face, set core, and replace cope as in Fig. 144.



PATTERN TO BE MOULDED

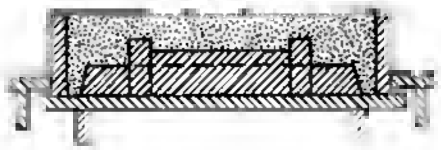


Fig. 142.

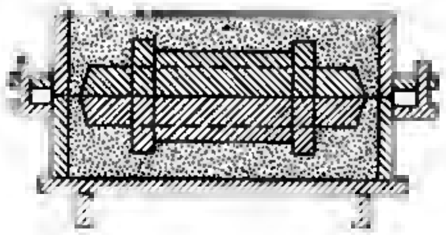


Fig. 143.

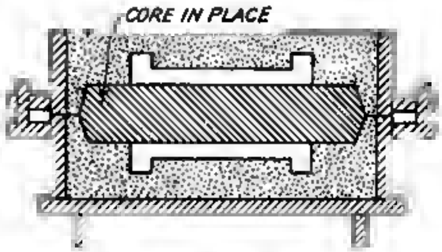
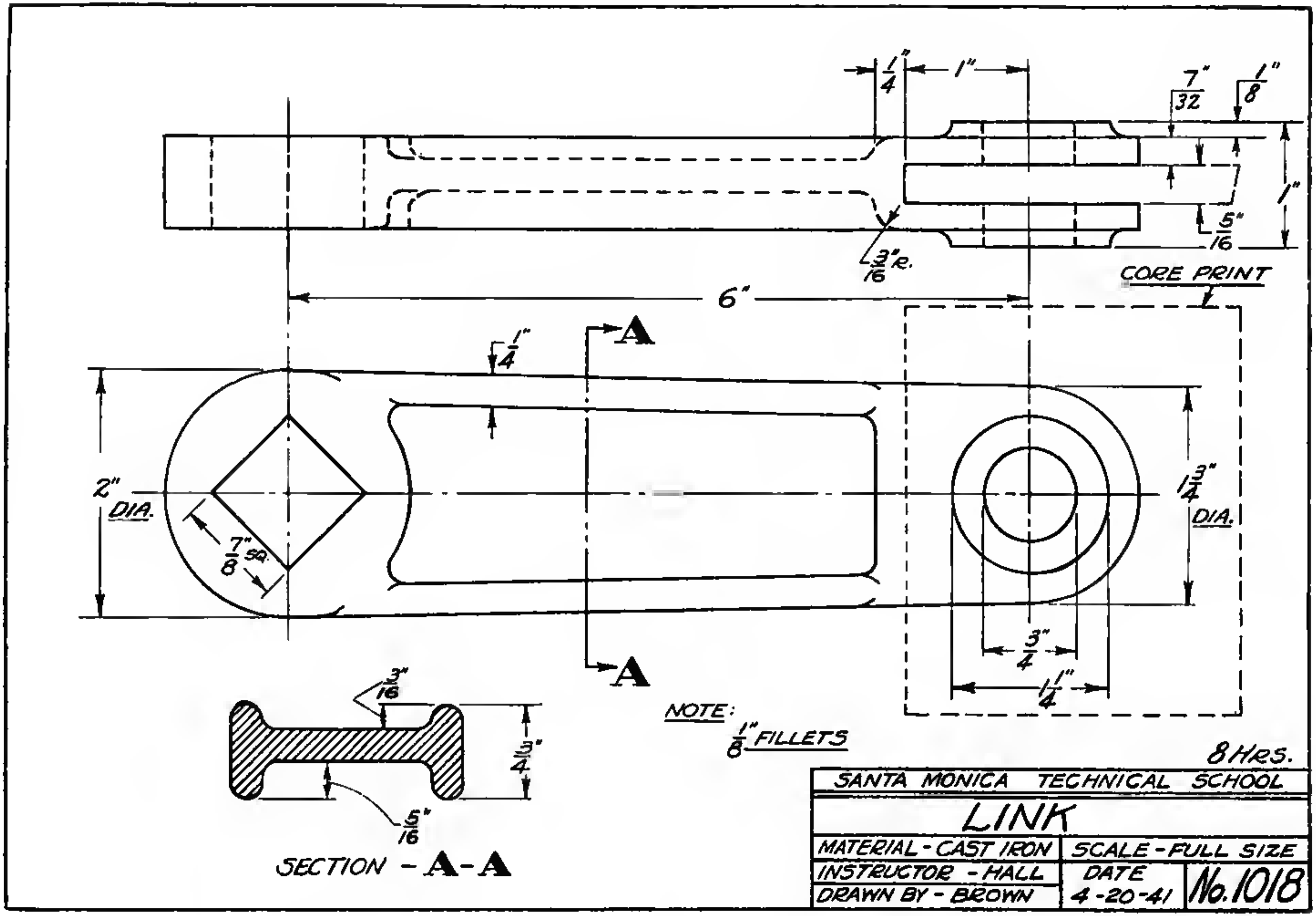


Fig. 144.



1/4"
1"
7/32"
1/8"
1"
5/16"
3/16" R.
CORE PRINT
6"
A
1/4"
2" DIA.
7/8" SQ.
1 3/4" DIA.
3/4"
1 1/4"
A
3/16"
3/4"
5/16"
SECTION - A-A
NOTE: 1/8" FILLETS
8 HRS.
SANTA MONICA TECHNICAL SCHOOL
LINK
MATERIAL - CAST IRON
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 4-20-41
DRAWN BY - BROWN
No. 1018

49. HOW TO MAKE AND USE FACEPLATES

The metal plate that screws on the inside or outside of the lathe to which the work is fastened is called a *faceplate*.

Study Figs. 145 to 150 for the construction of wood faceplates.

The patternmaker is often forced to use a wood faceplate in connection with the metal one. This is done sometimes to enlarge the faceplate, to glue or screw the work while turning, to turn the opposite side after rechucking a pattern, to build up a circular pattern as segment work, and for many other uses. This wood faceplate should always be trued up in the lathe before starting a new job or it will wobble and the face will not run true, thereby ruining the work.

A small wood faceplate may be cut out of regular pattern lumber, such as sugar or white pine of the necessary diameter, and used without any back bracing (Fig. 146).

A plate up to approximately 24 in. may be braced by screwing one wide piece of cross grain on the back to hold it straight (Fig. 147); or if the plate is to be made up of heavier stock, such as 2 in., two braces may hold it better (Fig. 148). Do not use glue in cross-grain work, as one piece will shrink one way and the other piece the opposite way, resulting in a crocked or wobbly plate.

Plenty of screws should be used to hold the plate together and as a safety measure. Screws alone will let the lumber come and go, as we call it, which means the lumber slips back and forth in changeable weather without warping to any great extent.

Larger faceplates may be braced in different ways to hold their shape fairly accurately. Two pieces halved together for the back brace and four segments screwed on the face make a good sturdy plate for medium-sized work (Fig. 149).

Still larger plates may be made up of three or four braces running straight through and cut out in the center similar to halving together. Naturally the larger the plate, the more bracing will be needed. In even larger work, six or eight braces are used running to the center (Fig. 150) for the back bracing, and the metal plate is used to reinforce the center, which should be bolted on. The segments on the face, with joints on the center of the braces (Fig. 150), will make a good faceplate that will last for years.

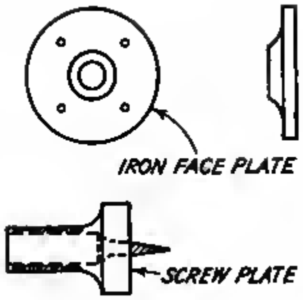


FIG. 145.

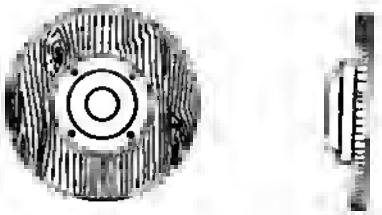


FIG. 146.

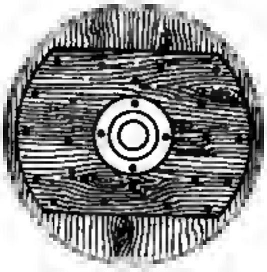


FIG. 147.

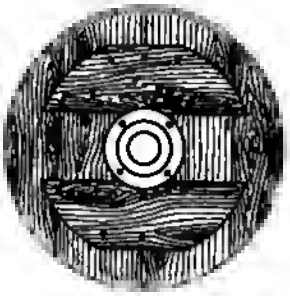


FIG. 148.

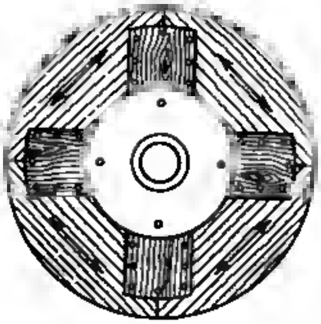


FIG. 149.

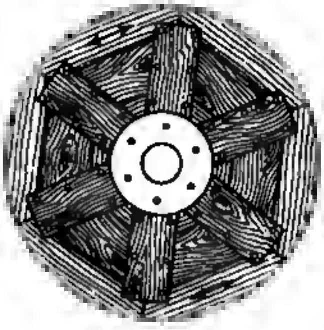
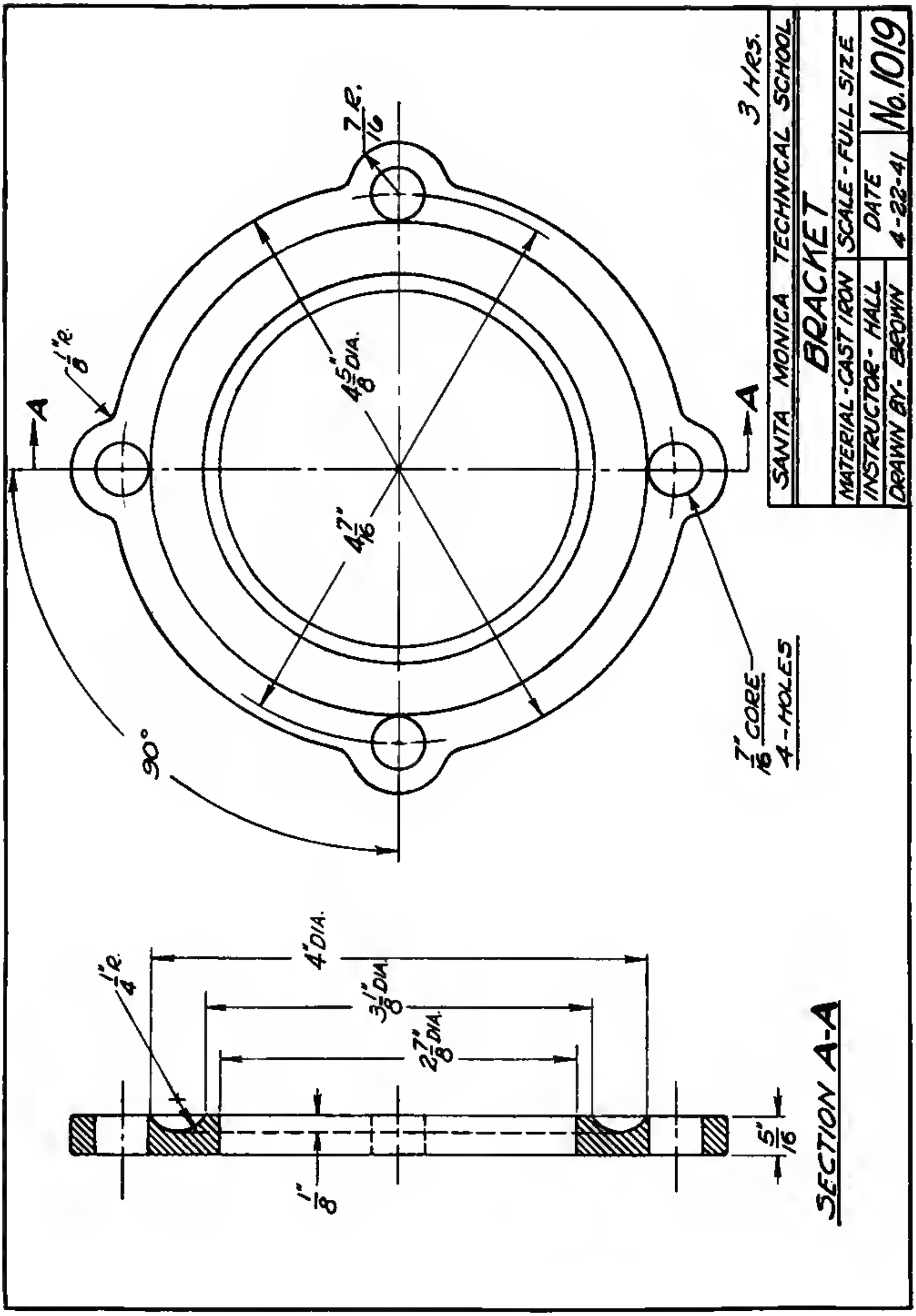


FIG. 150.


SANTA MONICA TECHNICAL SCHOOL
BRACKET
MATERIAL-CAST IRON
SCALE-FULL SIZE
INSTRUCTOR-HALL
DATE 4-22-41
DRAWN BY-BROWN
No. 1019
3 Hrs.
A
A
$\frac{7}{16}$" R.
$\frac{1}{8}$" R.
$4\frac{5}{8}$" DIA.
$4\frac{7}{16}$"
90°
$\frac{7}{16}$" CORE
4-HOLES
$\frac{1}{4}$" R.
4" DIA.
$3\frac{1}{8}$" DIA.
$2\frac{7}{8}$" DIA.
$\frac{1}{8}$"
$\frac{5}{16}$"
SECTION A-A

50. HOW TO MAKE PATTERNS WITH DOUBLE CUTS

When a pattern is to be made with a double cut, that is, cut on two sides as illustrated, the patternmaker should cut stock the proper thickness, or $1\frac{1}{2}$ in. The dotted lines show approximate width and length on the drawing.

Make a layout of the pattern on top (this may be called the face), and one edge of the stock. Next saw out and finish to the pattern lines (Fig. 151). All center lines should be drawn on the newly cut surfaces, while the square and gage can be used on a straight surface. Now the two pieces *A* and *B* should be nailed back in place with small nails or brads just enough to hold it together. The pattern should be sawed out and finished to lines *C* and *D* (Fig. 152). The patternmaker can then trim up around the bosses on the ends of the pattern and it is finished.

A job of this type can be laid out and cut while the faces are square, thus not only eliminating much time but getting the pattern made closer to the dimensions than any other way.

The measurements on the blueprint are given on a flat surface; therefore the pattern should be laid out on a flat surface, as it would differ from the blueprint if laid out on a curved surface

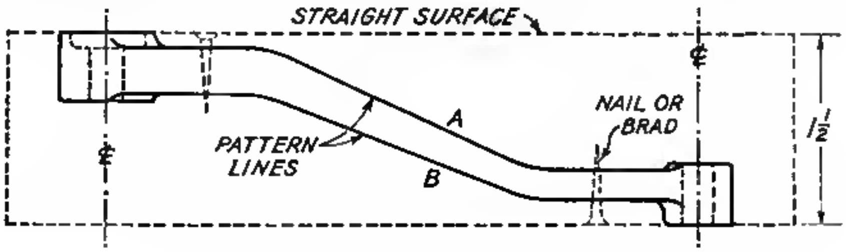


Fig. 151.

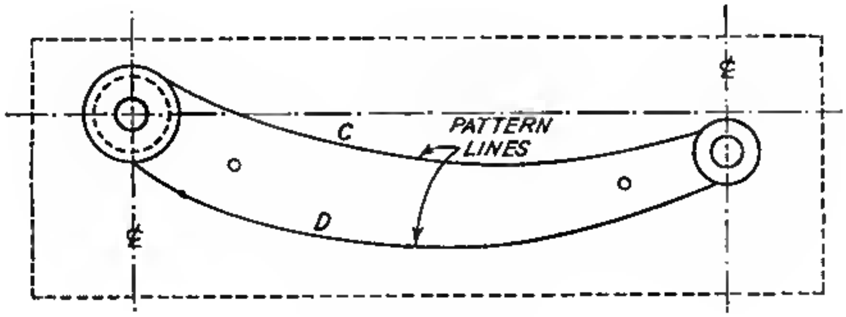
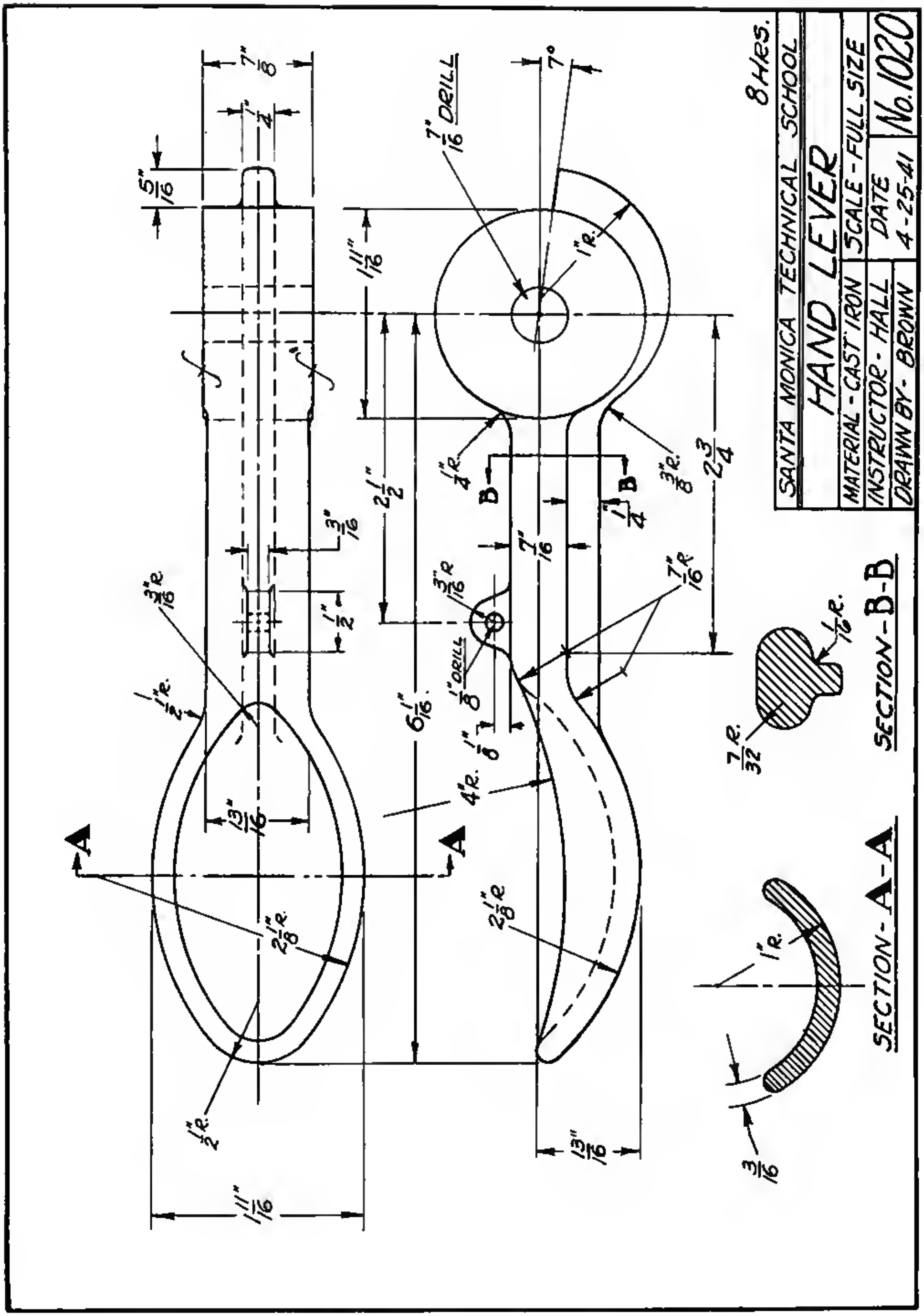
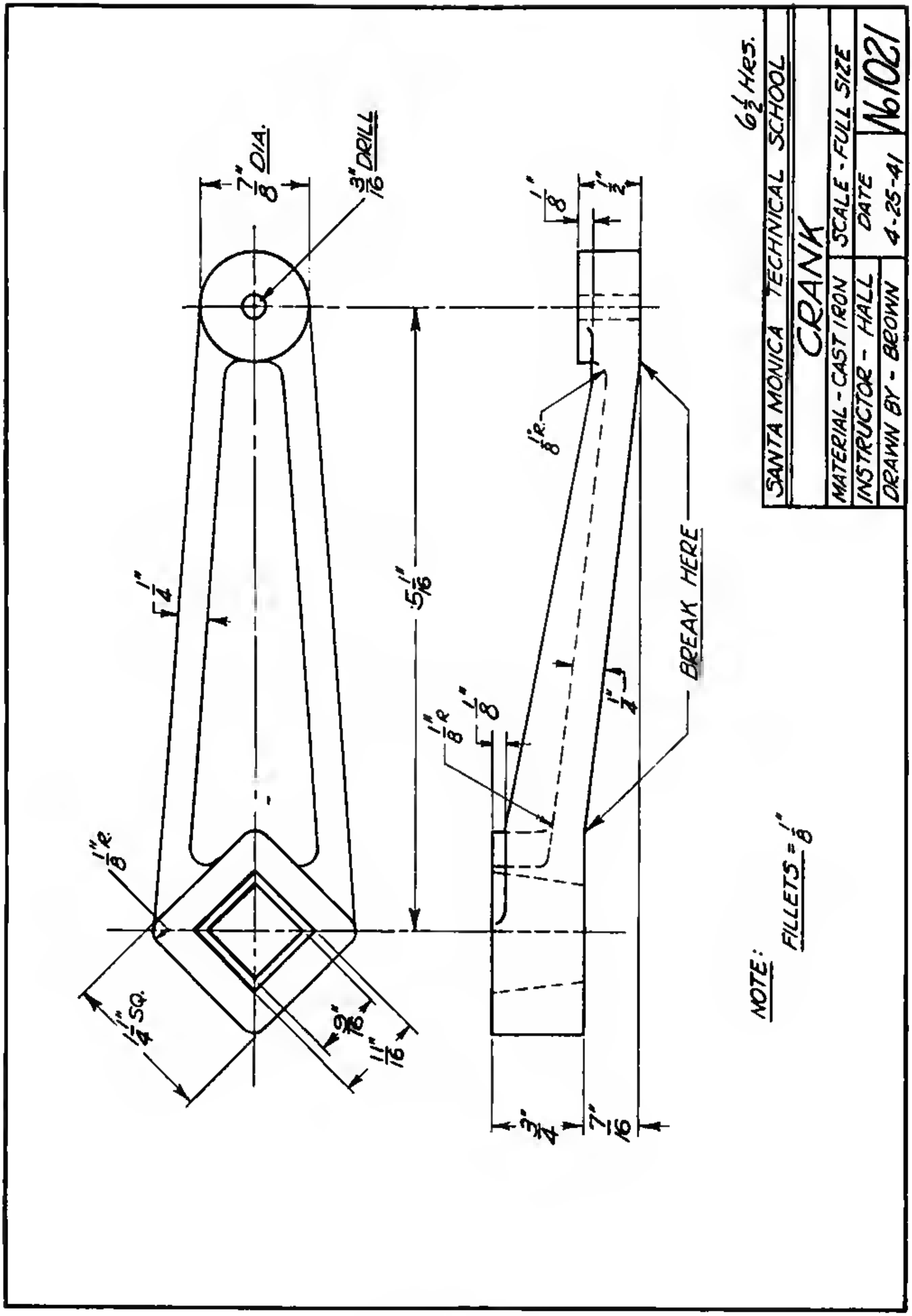
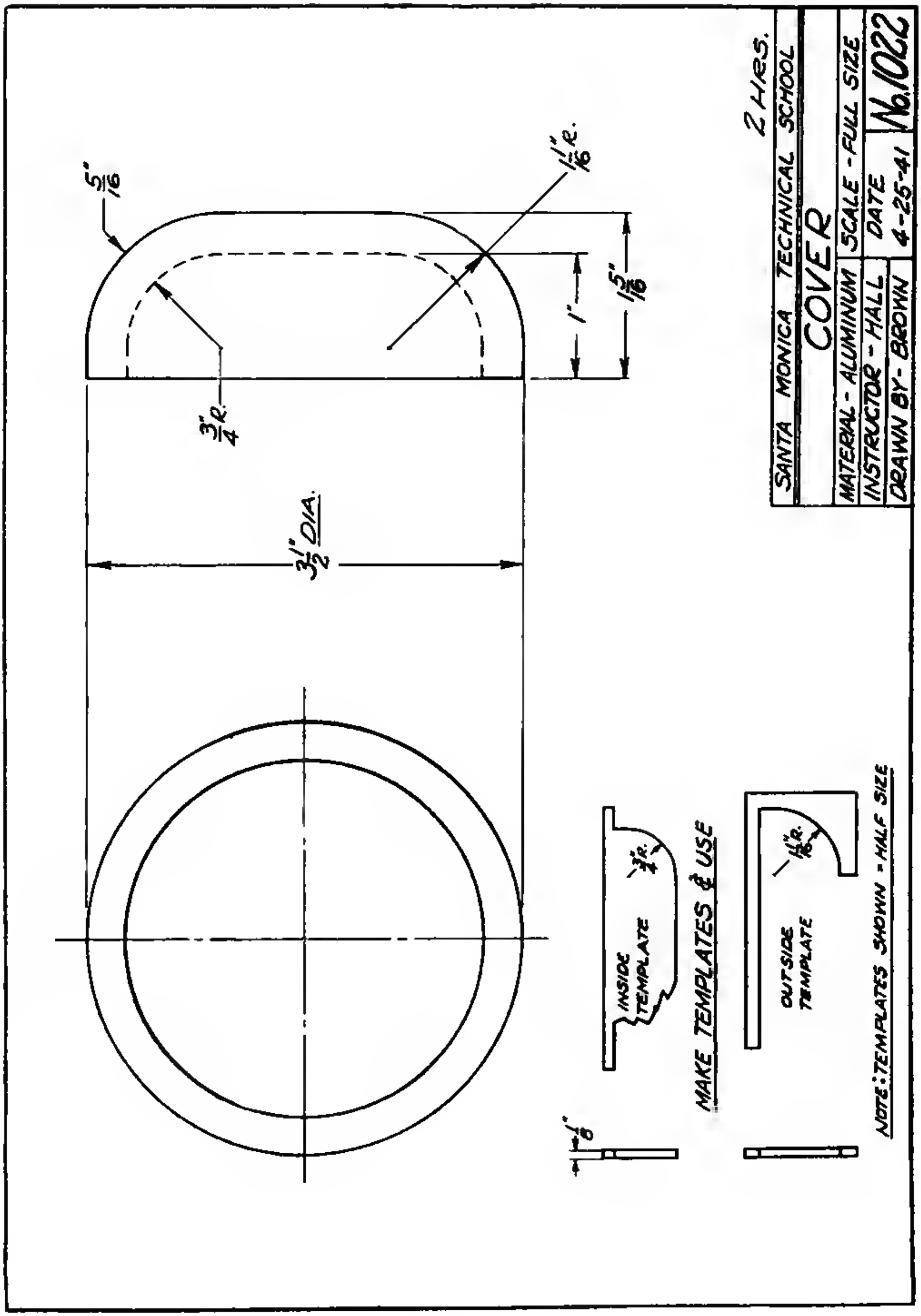


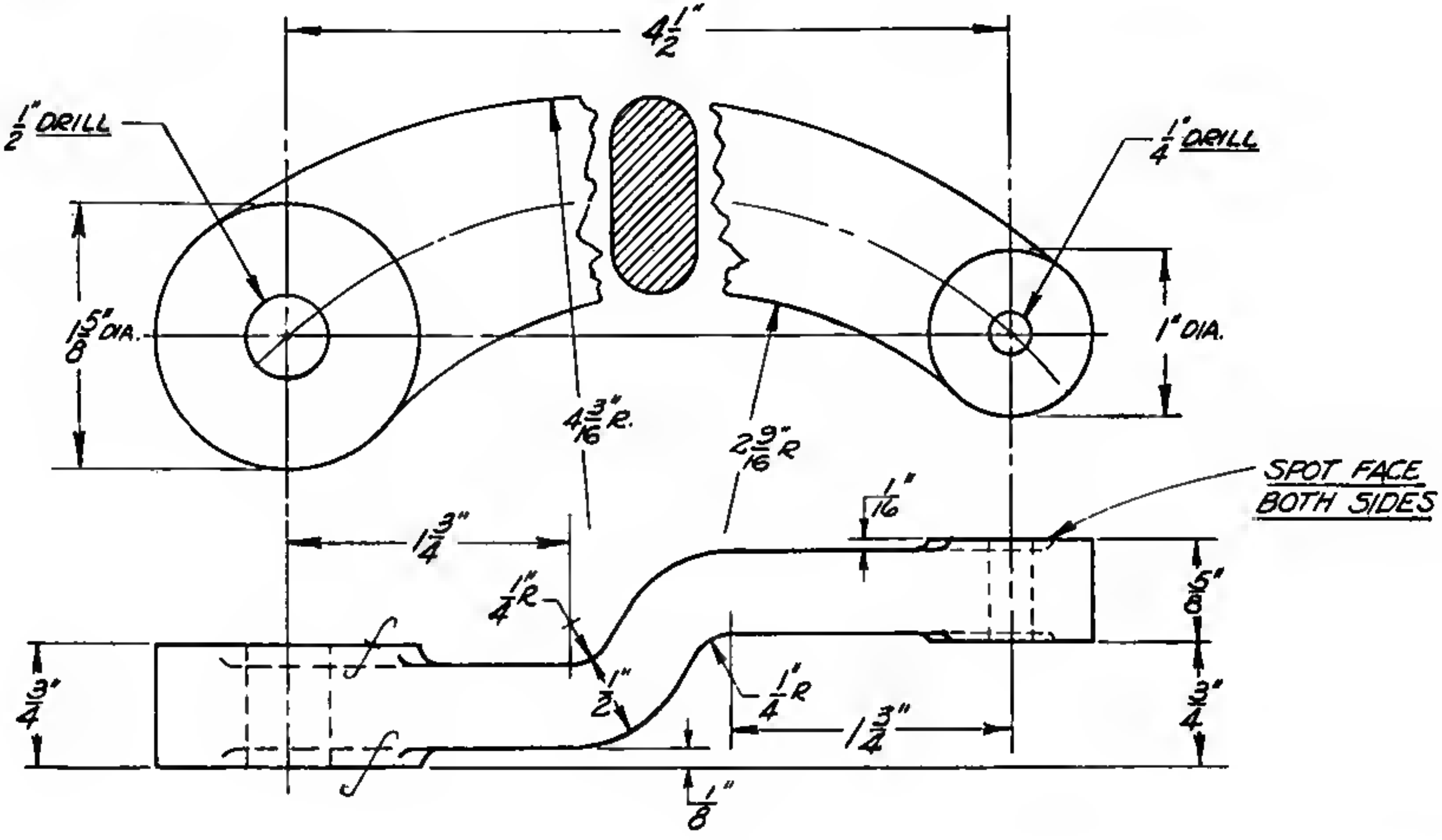
Fig. 152.


8 HRS.
SANTA MONICA TECHNICAL SCHOOL
HAND LEVER
MATERIAL - CAST IRON
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 4-25-41
DRAWN BY - BROWN
No. 1020
7/16" DRILL
1/8" DRILL
SECTION - A-A
SECTION - B-B



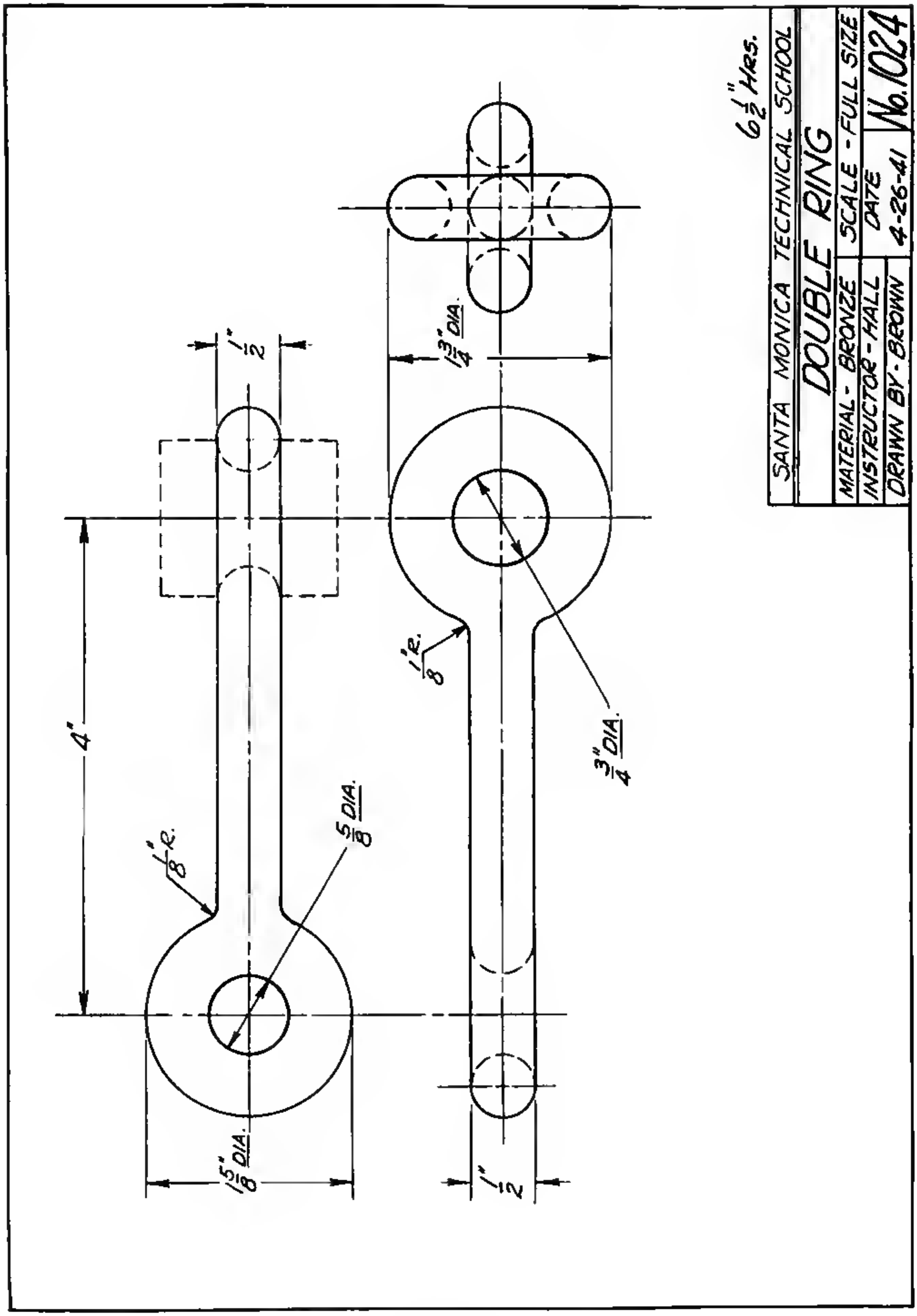
SANTA MONICA TECHNICAL SCHOOL
CRANK
MATERIAL - CAST IRON
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 4-25-41
DRAWN BY - BROWN
No 1021
6½ HRS.
NOTE: FILLETS = 1/8"
BREAK HERE
7/8" DIA.
3/16" DRILL
5 1/16"
1 1/4" SQ.
9/16"
11/16"
1/8" R.
1/4"
1/8"
1/2"
3/4"
7/16"


2 HRS.
SANTA MONICA TECHNICAL SCHOOL
COVER
MATERIAL - ALUMINUM
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 4-25-41
DRAWN BY- BROWN
No. 1022
5/16"
1 1/16" R.
1"
1 5/16"
3/4" R.
3 1/2" DIA.
INSIDE TEMPLATE
3/4 R.
OUTSIDE TEMPLATE
1 1/16 R.
1/8"
MAKE TEMPLATES & USE
NOTE: TEMPLATES SHOWN - HALF SIZE



5 1/2 HRS.

SANTA MONICA TECHNICAL SCHOOL	
CONNECTING ROD	
MATERIAL - CAST IRON	SCALE - FULL SIZE
INSTRUCTOR - HALL	DATE 4-26-41
DRAWN BY - BROWN	No. 1023



6 1/2" HRS.
SANTA MONICA TECHNICAL SCHOOL
DOUBLE RING
MATERIAL - BRONZE
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 4-26-41
DRAWN BY - BROWN
No. 1024
1/2"
1 3/4" DIA.
1/8" R.
3/4" DIA.
4"
1/8" R.
5/8 DIA.
1 5/8" DIA.
1/2"

51. HOW TO USE WING CORES AND WING PRINTS

Wing prints are used when an opening or hole is to be cored above or below the parting line (Fig. 153).

Many times, this type of print is used to core behind or on top of bosses (Fig. 154).

In somc cases the wing core may be used to advantage by the molder to shorten the cope (Fig. 155).

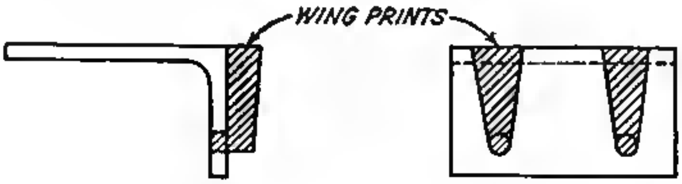


Fig. 153.

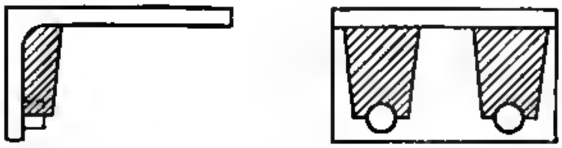


Fig. 154.

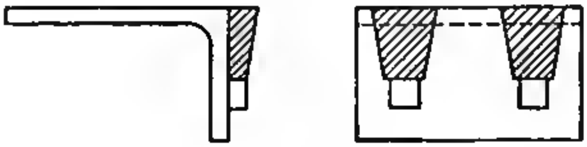
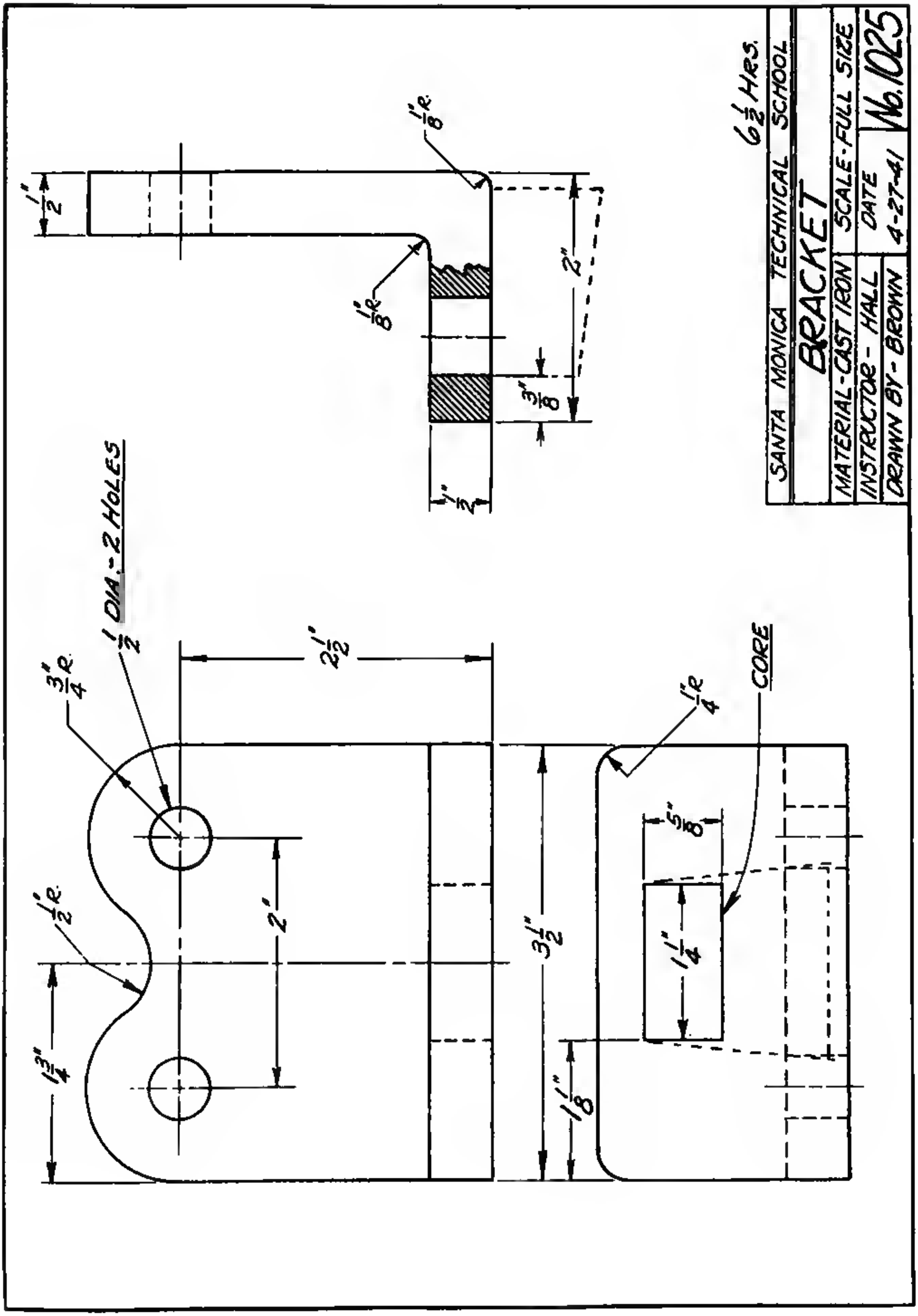


Fig. 155.



SANTA MONICA TECHNICAL SCHOOL
BRACKET
MATERIAL-CAST IRON
SCALE-FULL SIZE
INSTRUCTOR - HALL
DATE 4-27-41
DRAWN BY - BROWN
No. 1025
6 1/2 HRS.
1/2 DIA.-2 HOLES
CORE

52. HOW TO TURN WOOD RING

In this work a band saw, jointer, table saw, drill press, scale, dividers, square, knife, screw driver, turning tools, lumber, screws, and sandpaper are needed.

1. Get out stock at least ¼ in. larger than the actual diameter wanted (shown in Fig. 156 by dotted lines).

2. Turn one-half of the pattern (Fig. 157*B*), using template.

3. Take the pattern off the faceplate, and fit this half of the pattern in a V-shape. (Turn in the faceplate shown in Fig. 158.)

4. The pattern is thus centered in the lathe, ready for turning to the other side, which will be fastened with screws from the back of the faceplate.

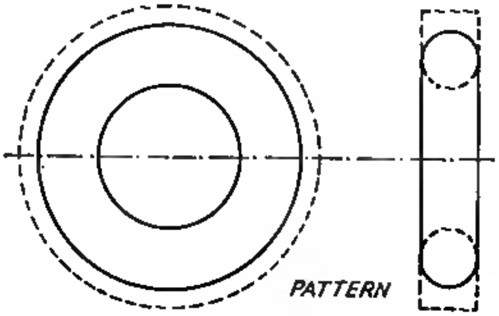


Fig. 156.

Fig. 157*A*.

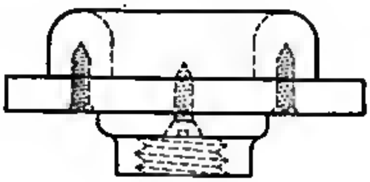


Fig. 157*B*.

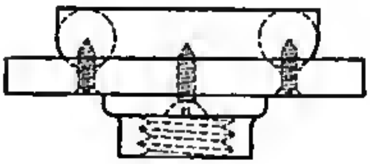


Fig. 158.

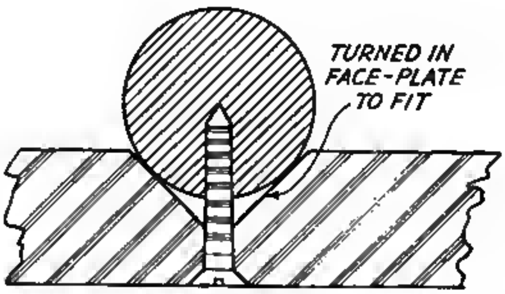
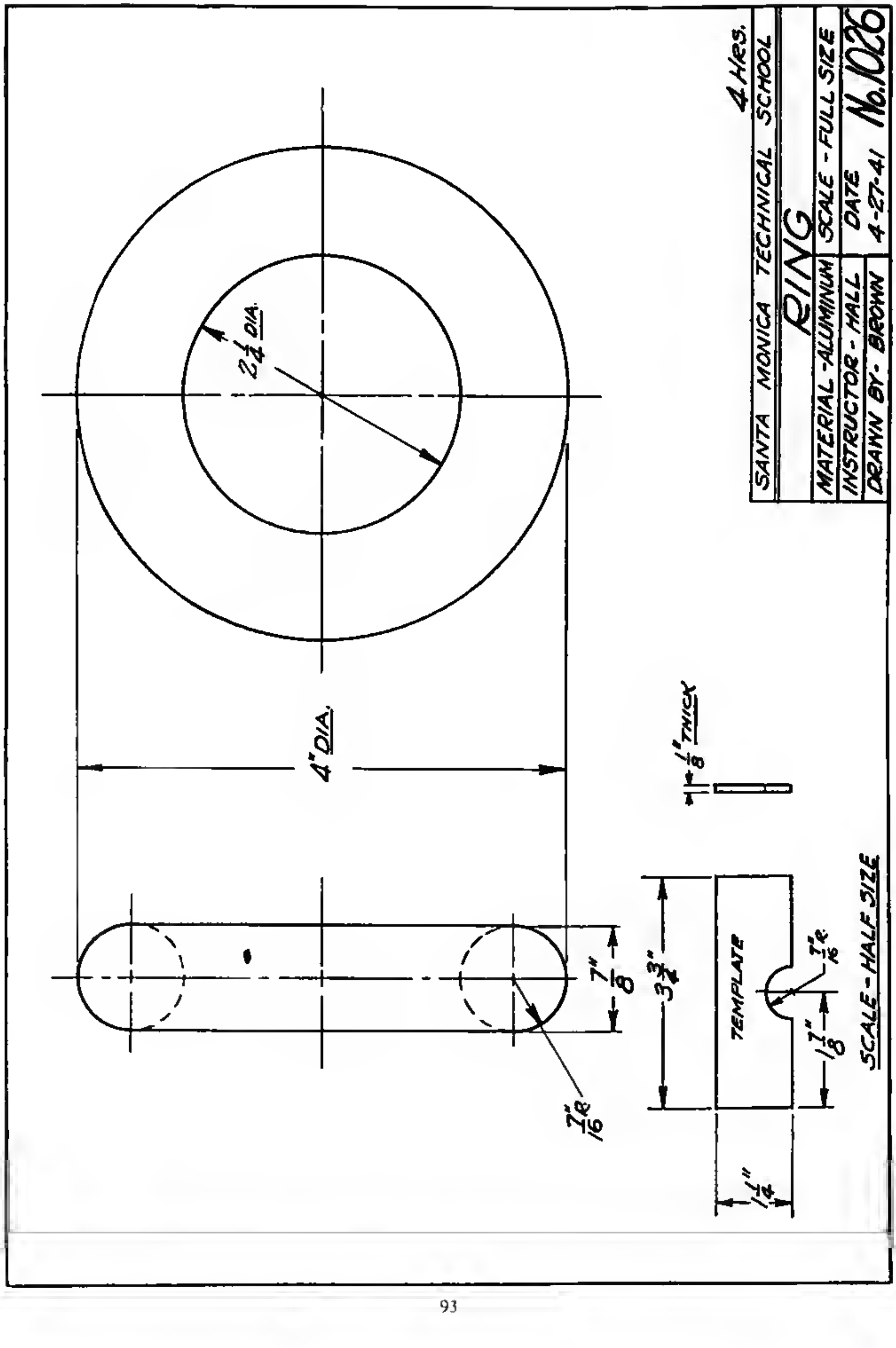
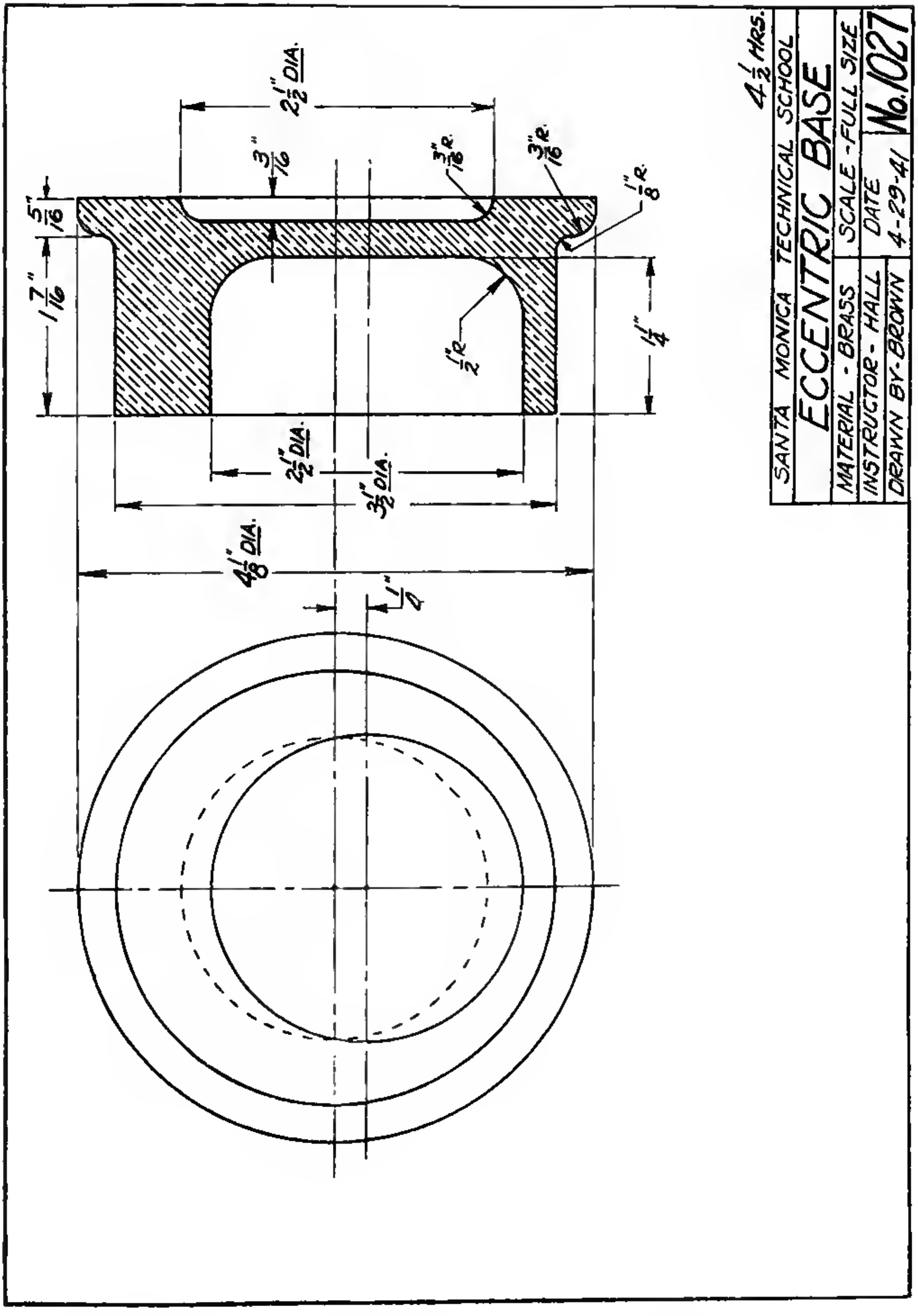
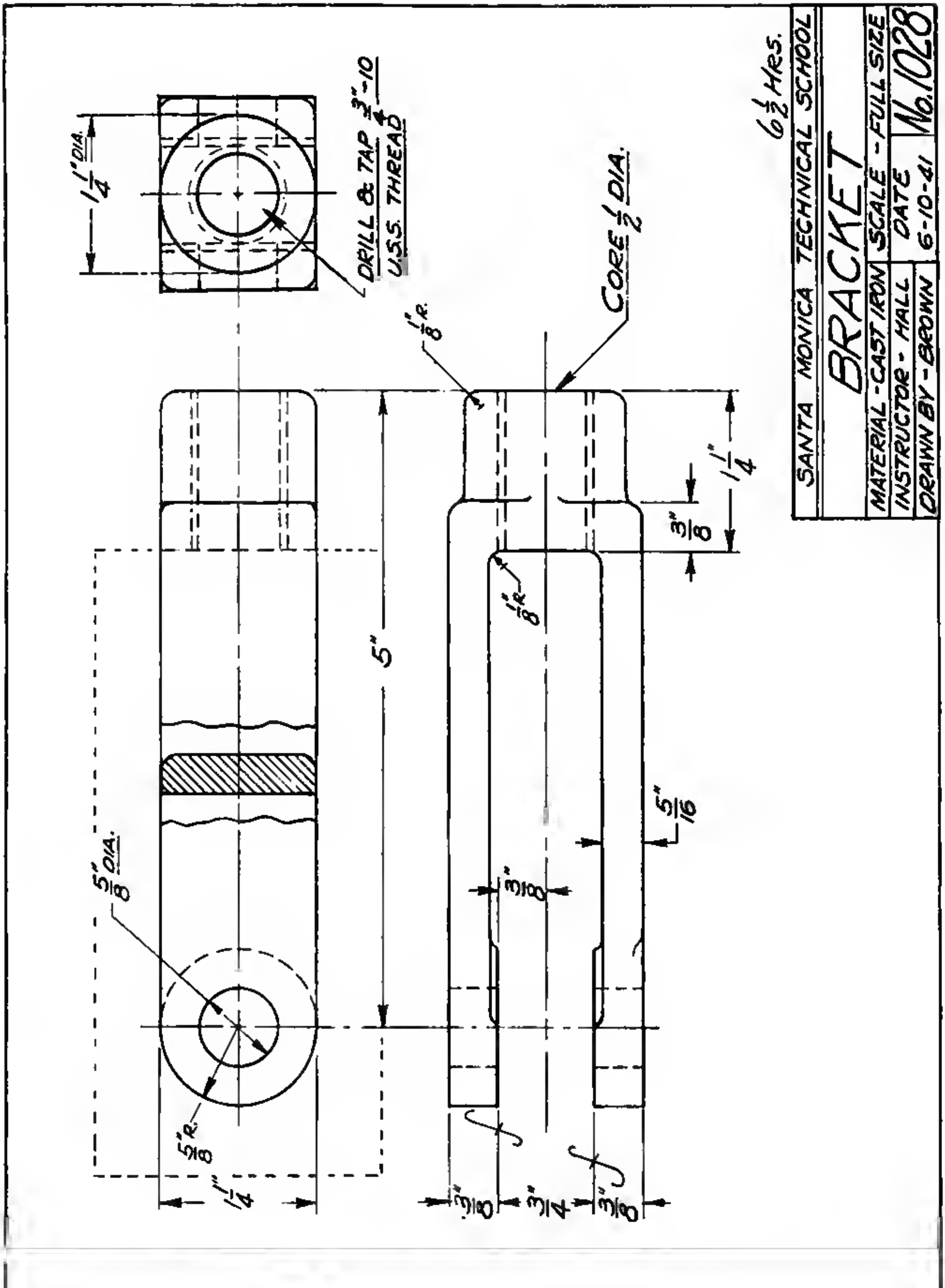


Fig. 159.


SANTA MONICA TECHNICAL SCHOOL
4 HRS.
RING
MATERIAL - ALUMINUM
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE
4-27-41
DRAWN BY - BROWN
No. 1026
2 1/4 DIA.
4" DIA.
1/8" THICK
7/8"
7/16 R
3 3/4"
TEMPLATE
7/16 R
1 7/8"
SCALE - HALF SIZE
1 1/4"


4 1/2 HRS.
SANTA MONICA TECHNICAL SCHOOL
ECCENTRIC BASE
MATERIAL - BRASS
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 4-29-41
DRAWN BY - BROWN
No. 1027
2 1/2" DIA.
3/16"
3/8" R.
3/16" R.
1/8" R.
5/16"
1 7/16"
1/2" R.
1 1/4"
2 1/2" DIA.
3 1/2" DIA.
4 1/8" DIA.
1/4"



SANTA MONICA TECHNICAL SCHOOL
BRACKET
MATERIAL - CAST IRON
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 6-10-41
DRAWN BY - BROWN
No. 1028
6 1/2 HRS.
DRILL & TAP 3/4"-10 U.S.S. THREAD
CORE 1/2 DIA.
1 1/4" DIA.
5/8" DIA.
5/8" R.
1/8" R.
5"
1 1/4"
3/8"
5/16"
3/4"

53. HOW TO USE CHAPLETS

Chaplets are used only in the foundry by the molder for the purpose of supporting cores that are not self-supporting. They may be used to hold the core up off the green sand mold when only one core print can be used and the core extends into the casting. They also may be used on top of the core to keep it from rising up into the cope while the mold is being poured (Fig. 160).

There are many types and sizes of chaplets, all made for their particular work. Some types lie between the core and the green sand (Fig. 161), while others are driven into the bottom board to support the core (Fig. 162). Still another type is adjusted to various thicknesses of metal by screwing the washer up and down on the stem (Fig. 163).

Chaplets are used to a great advantage in many types of machine work where weak points or leakage is not too important. Chaplets cannot be used in engine or water-jacket work, air compressors, or any kind of pipework where a leak would ruin the casting. At the point where the metal runs around the chaplet, there is likely to be a weak or porous place. Castings may be lost easily if the wrong type of chaplet is used, for the chaplet may melt and let the core down and cut through the metal.

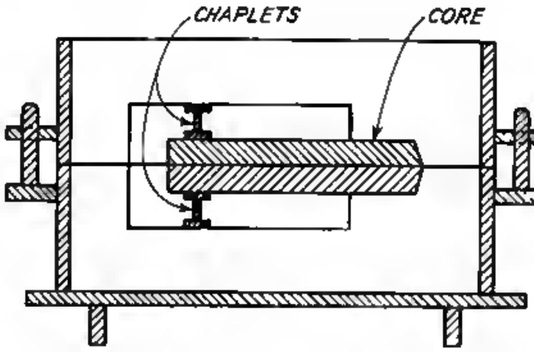


Fig. 160.

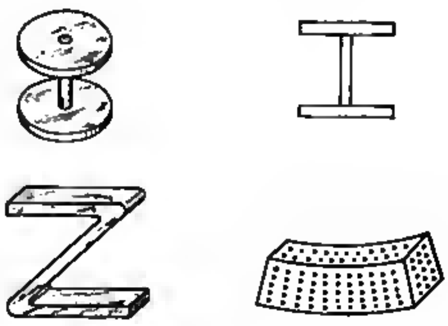


Fig. 161.

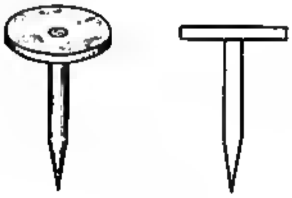


Fig. 162.

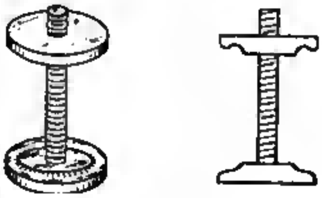


Fig. 163.

54. HOW TO USE BALANCE CORES AND CHAPLETS IN CORE WORK

When a core can be supported only at one end and extends into the casting, a balance core is used. This core should be made long enough to more than balance the overhanging core so it will not drop down. It may be necessary to put a head on this core to get extra weight if the core becomes too long. This would be used on a pattern such as that shown in the drawing (Fig. 164).

In larger work where heavier cores are used, chaplets are placed in the mold at *X* to keep the metal even on the casting. It is often advisable to set the chaplet on a ram-up core to keep it from settling in the green sand. A nail may be used as a support to hold the core in place, and another in the top to keep the core from floating.

Chaplets can be obtained for any thickness of metal.

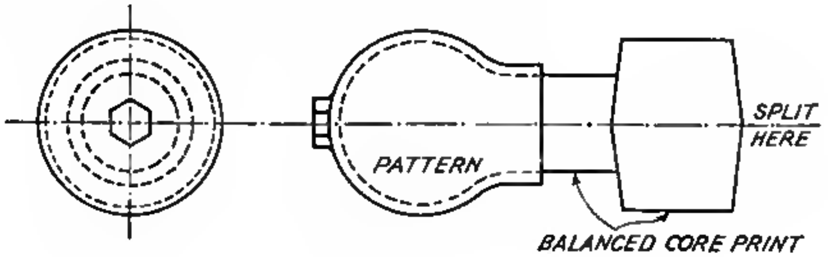


Fig. 164.

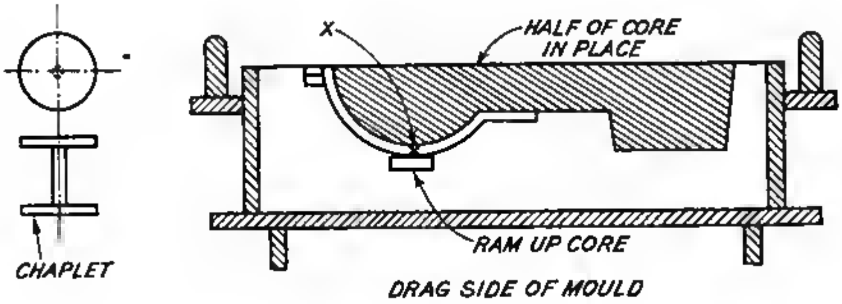
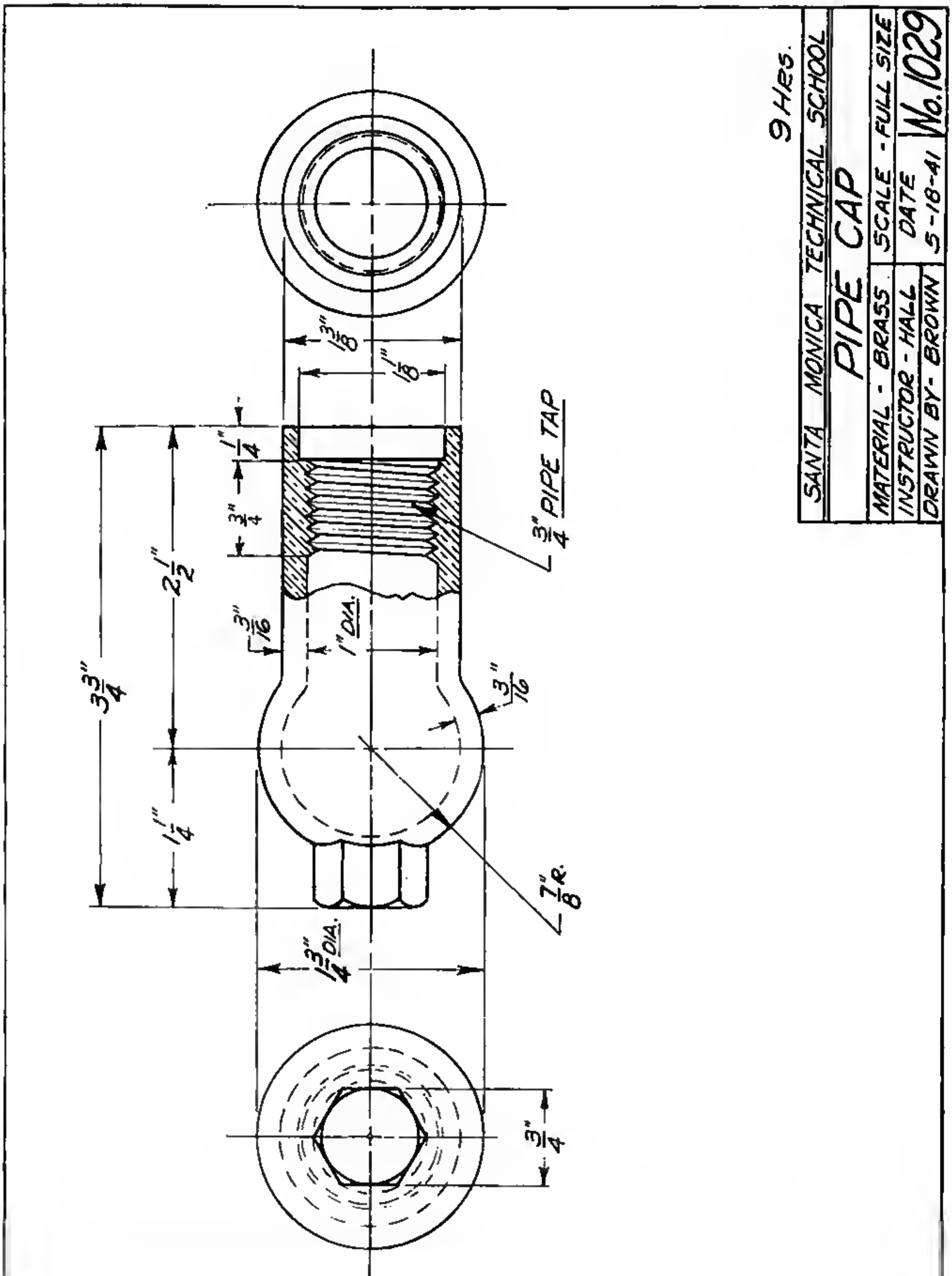
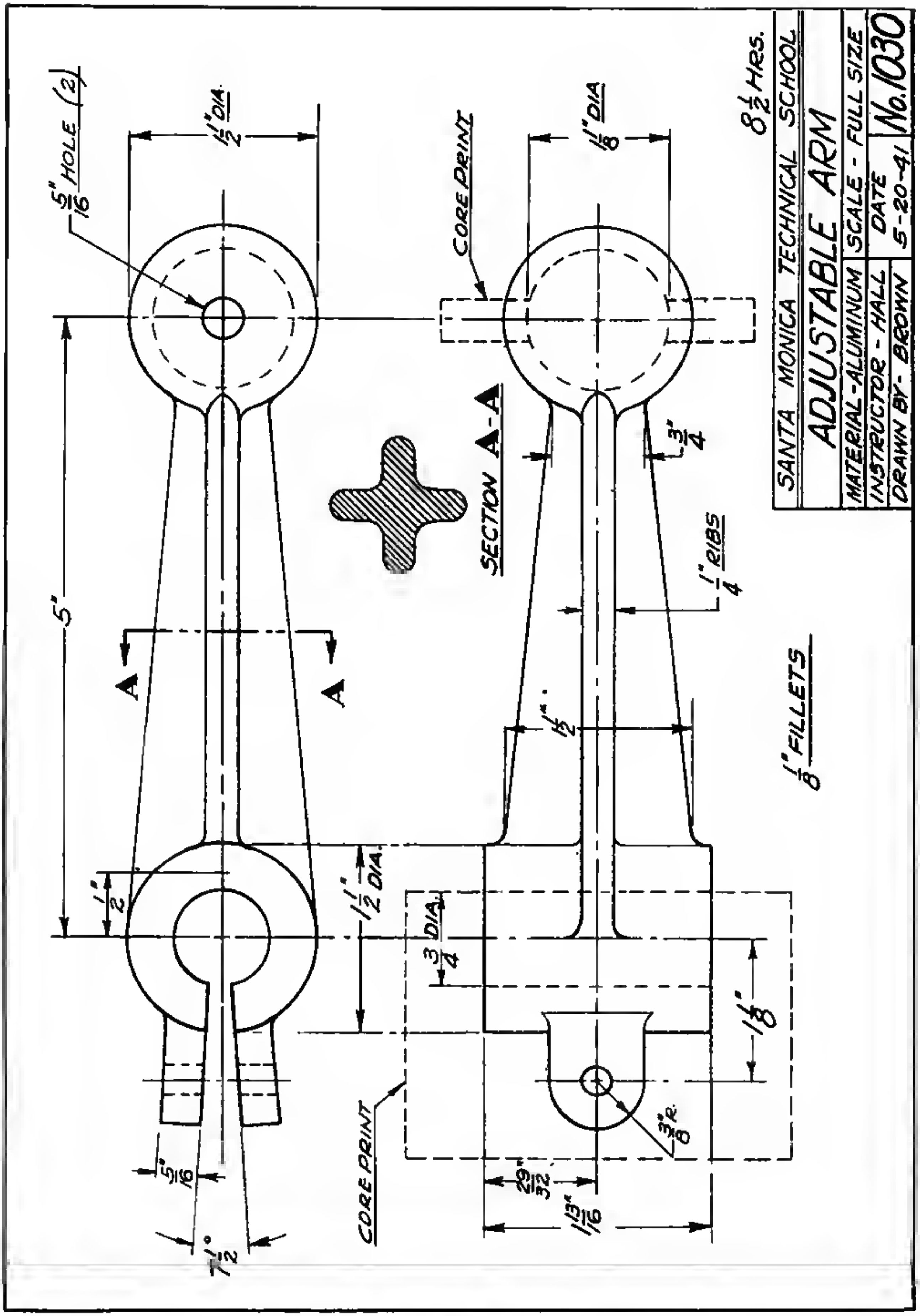
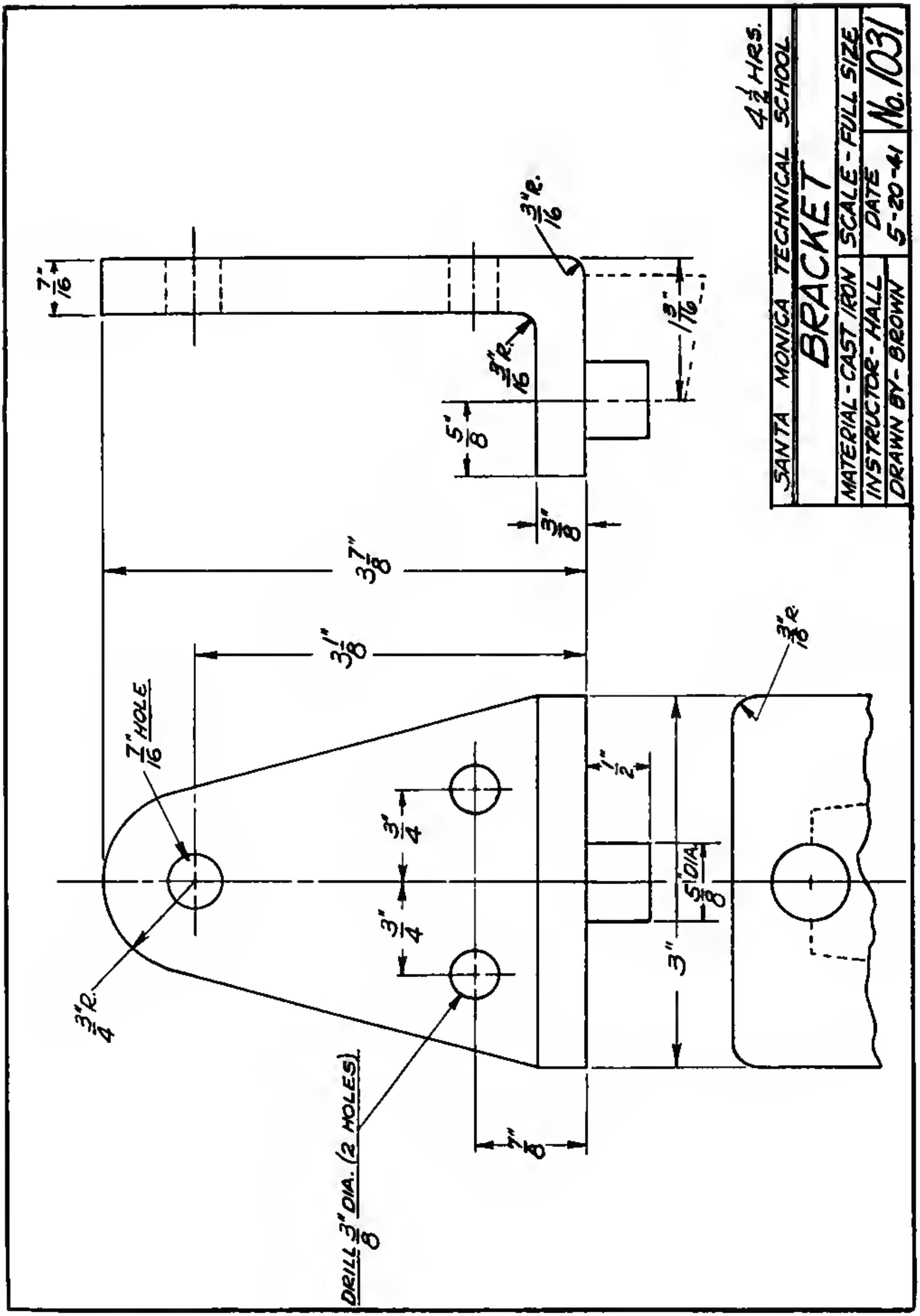


Fig. 165.


9 HRS.
SANTA MONICA TECHNICAL SCHOOL
PIPE CAP
MATERIAL - BRASS
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 5-18-41
DRAWN BY - BROWN
No. 1029
3/4" PIPE TAP
7/8" R.
1" DIA.
1 3/4" DIA.
3 3/4"
2 1/2"
1 1/4"
1 3/8"
1 1/8"
1/4"
3/4"
3/16"
3/16"
3/4"


SANTA MONICA TECHNICAL SCHOOL
ADJUSTABLE ARM
MATERIAL-ALUMINUM
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 5-20-41
DRAWN BY- BROWN
No.1030
8 1/2 HRS.
5/16" HOLE (2)
1 1/2" DIA.
CORE PRINT
1 1/8" DIA
SECTION A-A
3/4"
1/4" RIBS
1/8" FILLETS
5"
A
A
1/2"
1 1/2" DIA.
3/4 DIA.
1 1/8"
3/8" R.
29/32"
1 13/16"
5/16"
7 1/2°
CORE PRINT



4½ HRS.
SANTA MONICA TECHNICAL SCHOOL
BRACKET
MATERIAL - CAST IRON
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 5-20-41
DRAWN BY - BROWN
No. 1031
DRILL 3/8" DIA. (2 HOLES)
7/16" HOLE
3/4" R.
5/8" DIA.

55. HOW TO USE LAYOUTS

A full-sized layout should be made by the patternmaker for all complicated patterns with any extensive coring, for example, where cores interlock or when two cores are joined or butted together or where there are a number of surfaces to be finished. The layout board should be planed straight and true before the job is started. A good layout board is a great help in building up a pattern. The square and gage should be used on one side only. All lines should be marked with a sharp knife, gage and dividers, or trammels, and penciled in later. All finished surfaces should be marked in with a red or colored pencil to avoid confusion.

A layout of the full pattern is not always necessary if the pattern is symmetrical from the center line; it would be useless to draw in both halves. There are also times when only a certain section of the pattern is required. Naturally, one would use the same shrink rule on the layout as on the pattern. Lines of irregular curves may be picked off the layout board by placing small flat-headed nails with the heads in the lines to be picked up. After the heads are placed carefully in this line (Fig. 166), the stock is put on top at the right location and pressed down firmly or struck with a hammer to mark the stock with the nail heads. This process transfers the lines or points to the job. If this line is not distinct, a thin flexible piece of wood or metal called a *spline* is often used to fair in from one point to another.

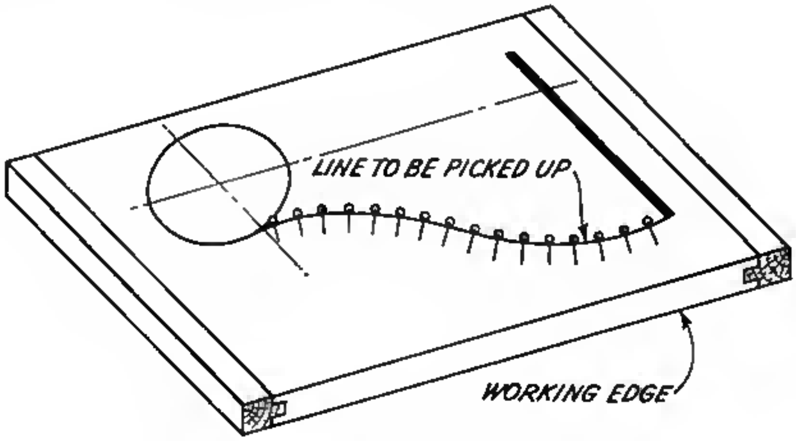
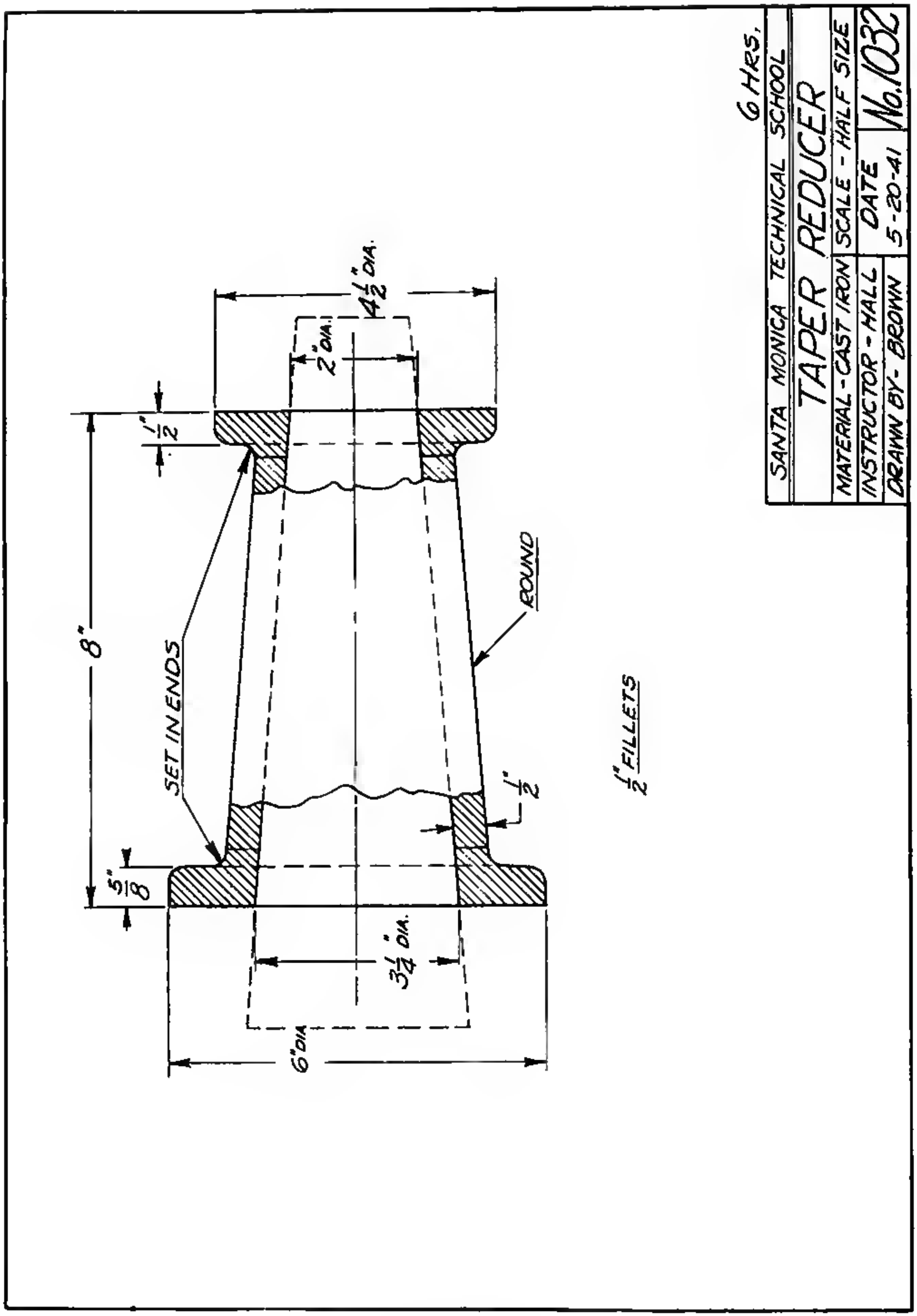
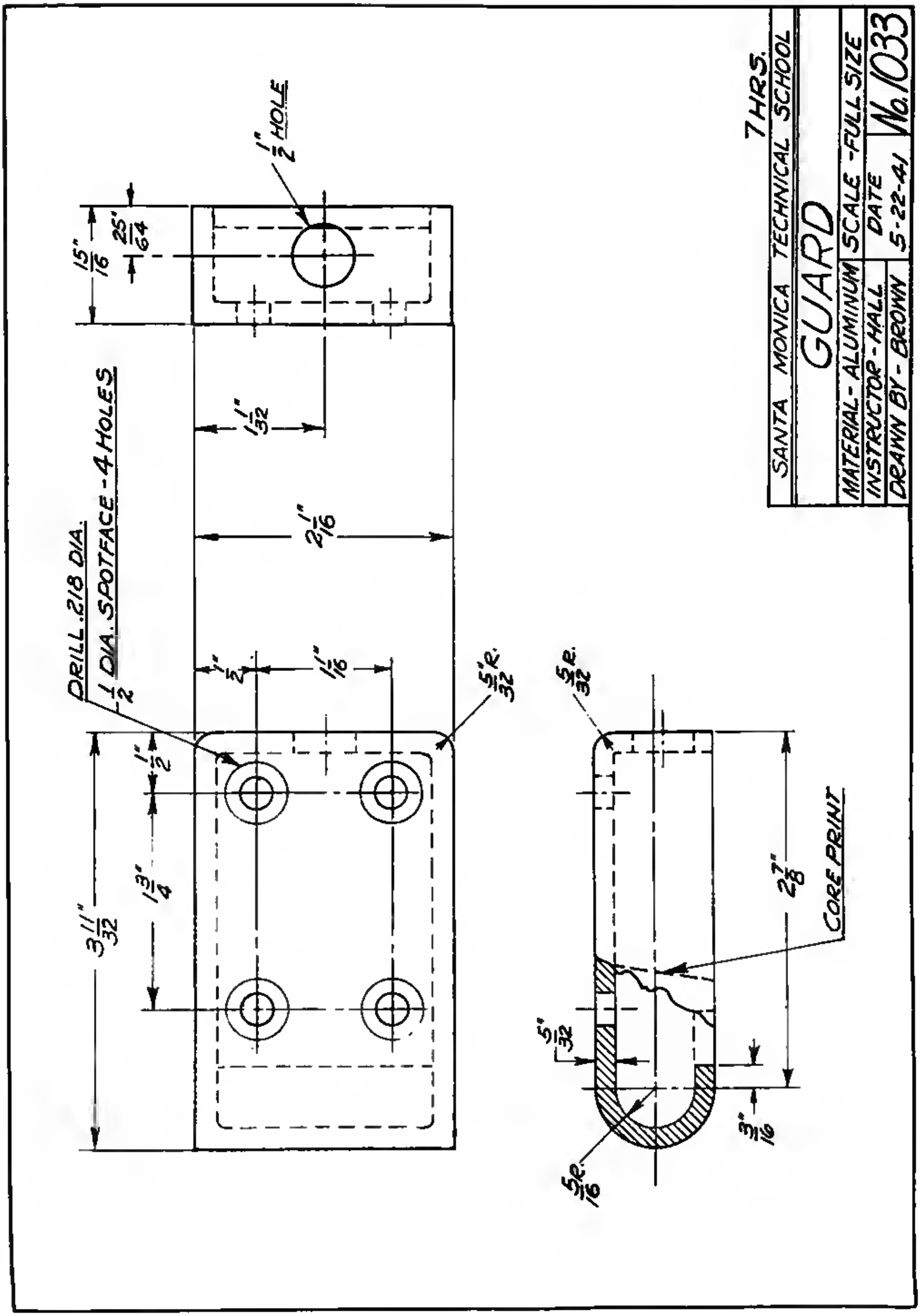
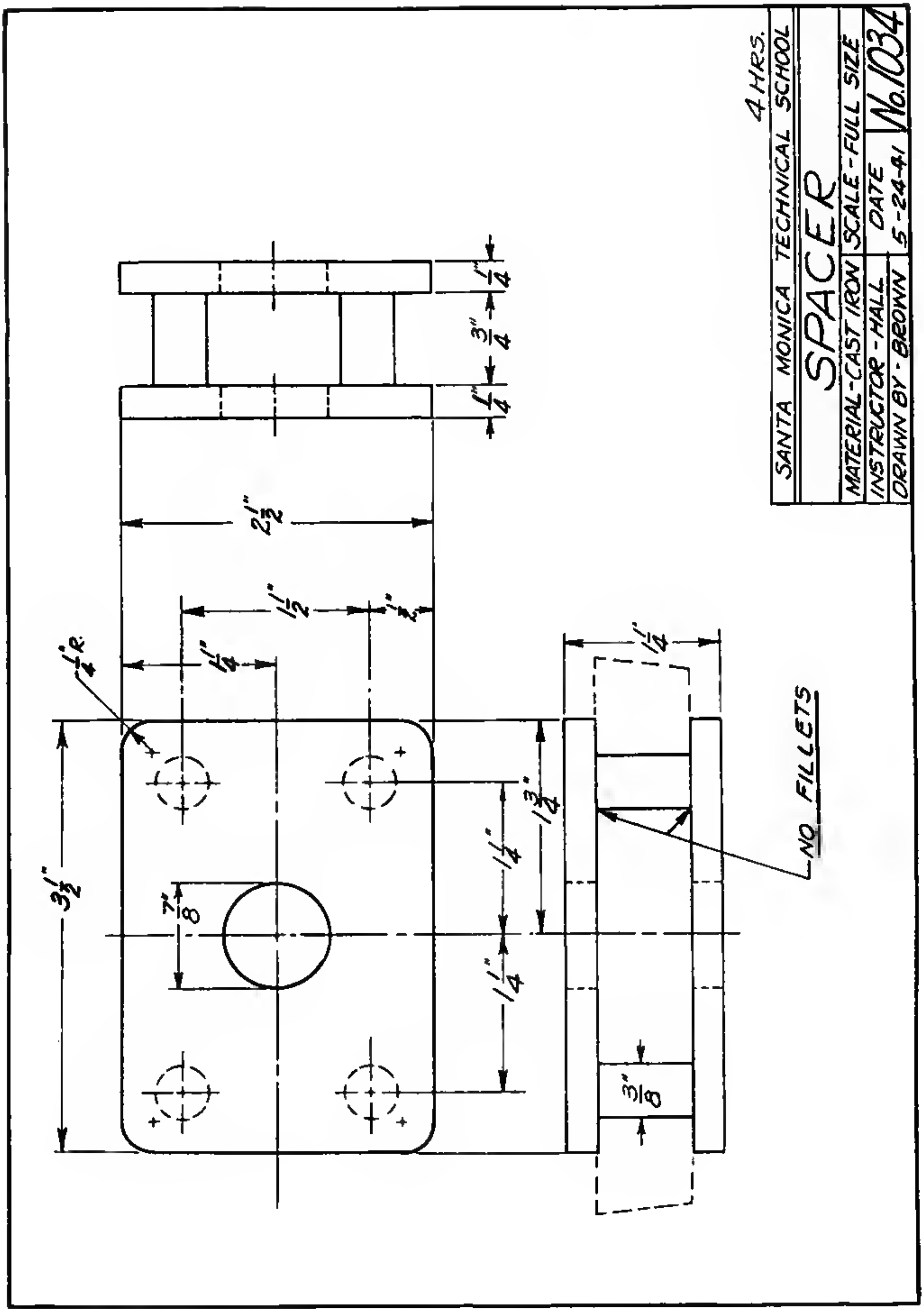
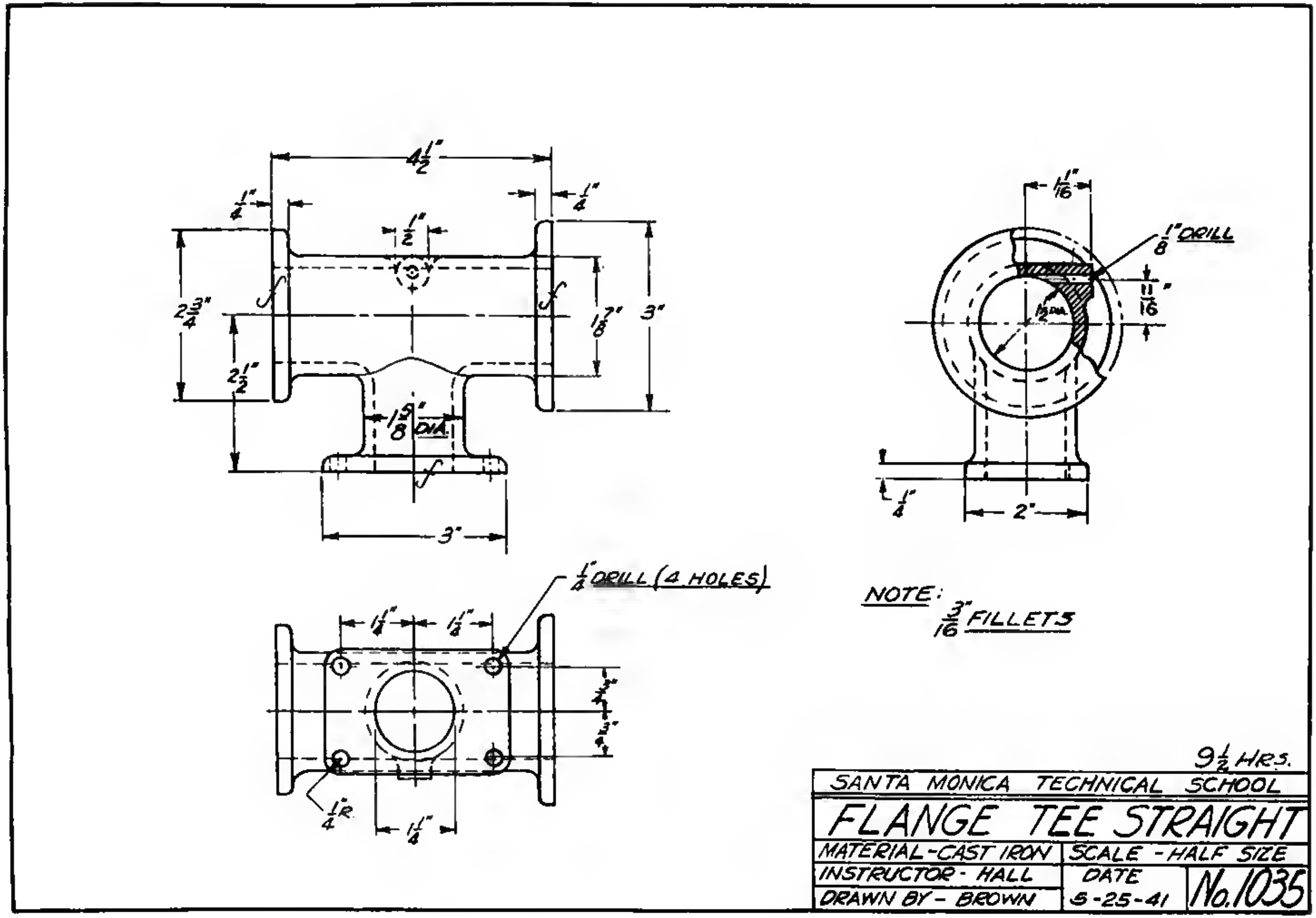


Fig. 166.


6 HRS.
SANTA MONICA TECHNICAL SCHOOL
TAPER REDUCER
MATERIAL-CAST IRON
SCALE - HALF SIZE
INSTRUCTOR - HALL
DATE
5-20-41
DRAWN BY- BROWN
No.1032
4 1/2" DIA.
2" DIA.
1/2"
8"
SET IN ENDS
ROUND
1/2" FILLETS
1/2"
5/8"
3 1/4" DIA.
6" DIA


7 HRS.
SANTA MONICA TECHNICAL SCHOOL
GUARD
MATERIAL - ALUMINUM
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 5-22-41
DRAWN BY - BROWN
No. 1033
DRILL .218 DIA.
1/2 DIA. SPOTFACE - 4 HOLES
1/2" HOLE
CORE PRINT
15/16"
25/64"
1 1/32"
2 1/16"
1/2"
1 1/16"
5/32 R.
3 11/32"
1 3/4"
2 7/8"
5/32"
3/16"
5/16 R.


4 HRS.
SANTA MONICA TECHNICAL SCHOOL
SPACER
MATERIAL-CAST IRON
SCALE-FULL SIZE
INSTRUCTOR-HALL
DATE 5-24-41
DRAWN BY-BROWN
No.1034
NO FILLETS

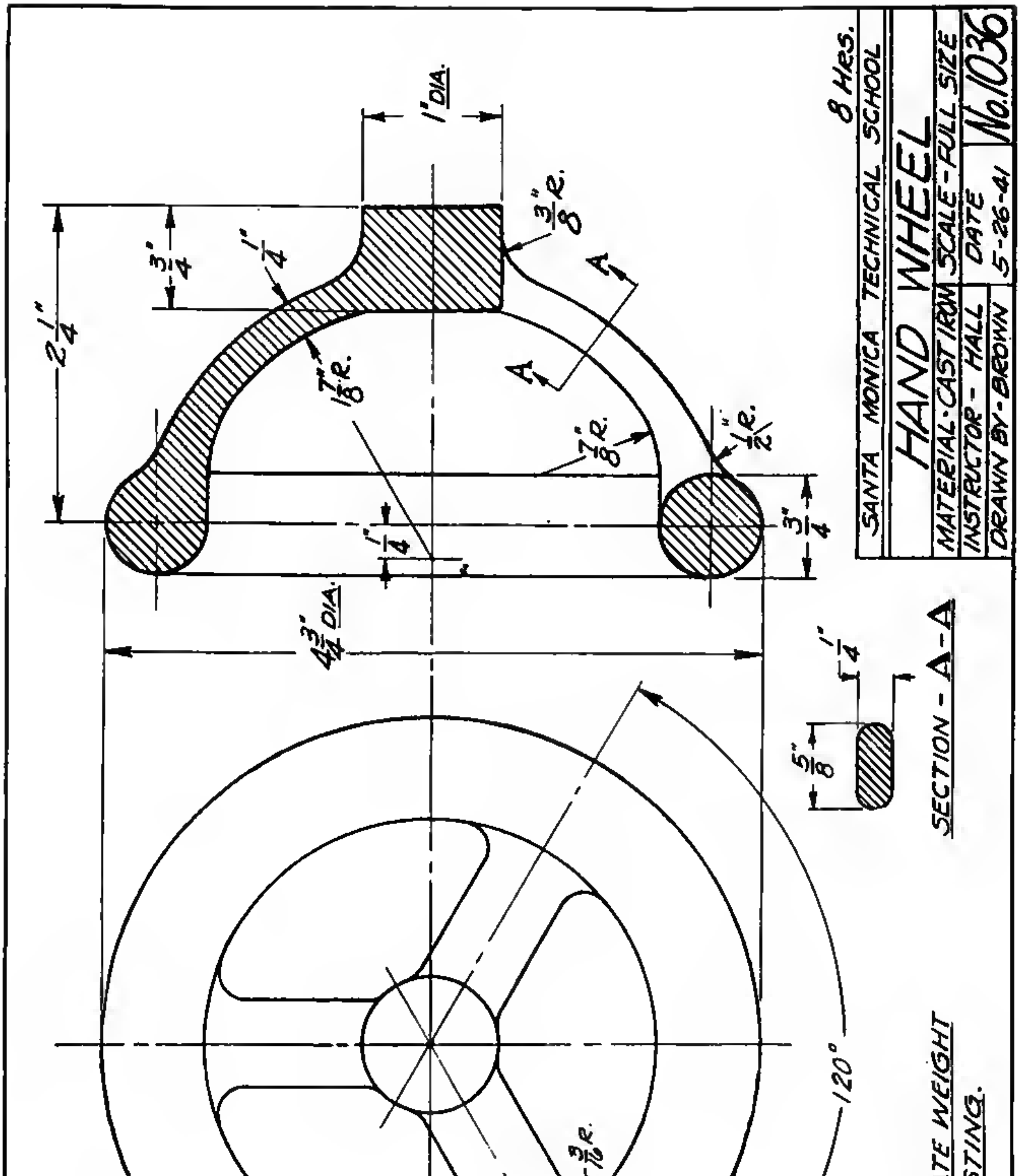

$4\frac{1}{2}''$
$\frac{1}{4}''$
$\frac{1}{2}''$
$2\frac{3}{4}''$
$1\frac{7}{8}''$
$3''$
$2\frac{1}{2}''$
$1\frac{3}{8}''$ DIA.
$3''$
$\frac{1}{16}''$
$\frac{1}{8}''$ DRILL
$\frac{11}{16}''$
$\frac{1}{2}$ DIA.
$2''$
$\frac{1}{4}''$
$\frac{1}{4}''$ DRILL (4 HOLES)
$1\frac{1}{4}''$
$\frac{3}{4}''$
$\frac{1}{4}''$R
NOTE:
$\frac{3}{16}''$ FILLETS
$9\frac{1}{2}$ HRS.
SANTA MONICA TECHNICAL SCHOOL
FLANGE TEE STRAIGHT
MATERIAL - CAST IRON
SCALE - HALF SIZE
INSTRUCTOR - HALL
DATE
5-25-41
DRAWN BY - BROWN
No. 1035

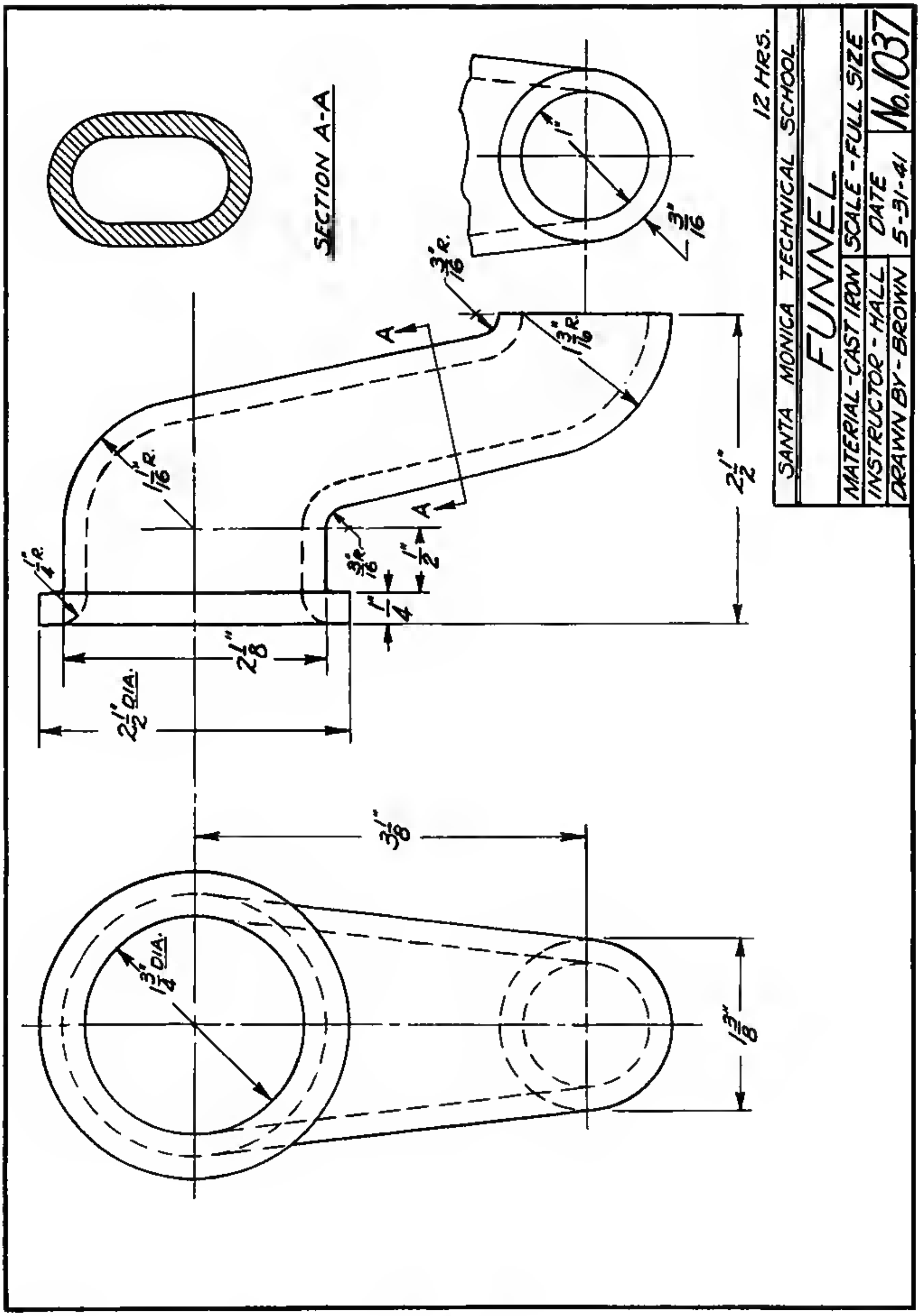
56. HOW TO ESTIMATE THE WEIGHTS OF CASTINGS

In estimating the weights of castings from wood patterns, the following rule is fairly close. Different grades of materials make it difficult to be exact.

This rule is used on patterns with no core prints.

Aluminum	is 6½	times pine pattern;	4⅓ times mahogany pattern
Cast iron	is 16	times pine pattern;	10½ times mahogany pattern
Malleable iron	is 16	times pine pattern;	10½ times mahogany pattern
Tin	is 16	times pine pattern;	10½ times mahogany pattern
Steel	is 17¼	times pine pattern;	11⅓ times mahogany pattern
Brass	is 18¾	times pine pattern;	12⅓ times mahogany pattern
Bronze	is 18⅞	times pine pattern;	12⅗ times mahogany pattern
Copper	is 19¼	times pine pattern;	12⅔ times mahogany pattern
Lead	is 25¼	times pine pattern;	16⅔ times mahogany pattern


SANTA MONICA TECHNICAL SCHOOL
8 HRS.
HAND WHEEL
MATERIAL-CAST IRON
SCALE-FULL SIZE
INSTRUCTOR - HALL
DATE
5-26-41
DRAWN BY - BROWN
No. 1036
SECTION - A-A
ESTIMATE WEIGHT OF CASTING.
1" DIA.
4 3/4" DIA.
2 1/4"
3/4
1/4"
3/8" R.
1 7/8 R.
7/8 R.
1/2" R.
3/4"
1/4"
5/8"
1/4"
3/16 R.
120°
A
A


SECTION A-A
12 HRS.
SANTA MONICA TECHNICAL SCHOOL
FUNNEL
MATERIAL-CAST IRON
SCALE-FULL SIZE
INSTRUCTOR-HALL
DATE 5-31-41
DRAWN BY-BROWN
No.1037
2½" DIA.
1¾" DIA.

57. HOW TO LAY OUT SEGMENTS FOR BUILT-UP PATTERNS

For this work a band saw, table saw, jointer, sander, hand plane, scale, dividers, knife, gage, lumber, and cardboard are needed.

1. Lay out one-sixth of the inside and outside circle wanted on cardboard or thin stock.
2. Add at least $\frac{1}{4}$ in. to the outside radius.
3. Take off at least $\frac{1}{4}$ in. on the inside radius.
4. Add $\frac{1}{16}$ in. to each end of the segment, and scribe to center. This will be sanded off when the segment is fitted.
5. Cut out segment which is to be used as a pattern for as many such pieces as are needed, making six to each layer.

Often when a shell pattern is turned, the inside of the pattern is turned first to fit a template. Then a series of $\frac{3}{16}$- or $\frac{1}{4}$-in. holes are drilled in a row through the pattern wall and plugged with short pieces of doweling as shown in Fig. 168. These are cut just as long as the thickness of the wall wanted on the finished pattern and glued in flush with the inside of the pattern. The outside is then turned down until the ends of the dowels are flush. By using this method you will be assured of the correct thickness of stock at all points. Many times an outside template is not needed.

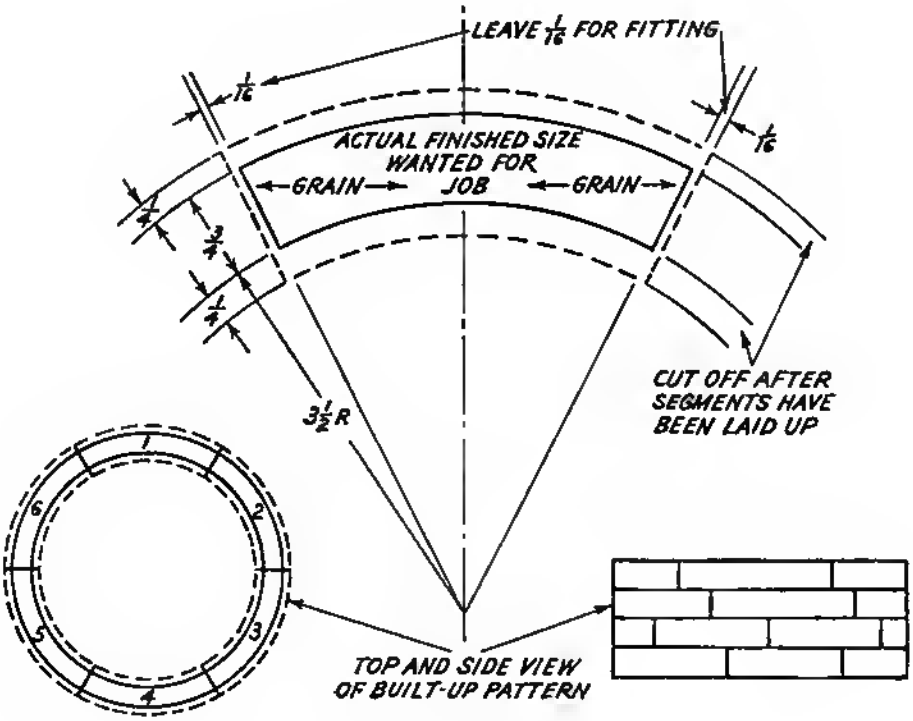


Fig. 167.

58. HOW TO DO SEGMENT WORK

Make a full-size layout or a section of the job. If the drawing calls for finish, add this with a red pencil. Then add the amount necessary to work the pattern down to the dimensions of the drawing. On medium-size turning jobs, add ¼ in. for this; if it is to be cut down by hand with a plane, spokeshave, etc., add less.

Always have at least three rows of segments or they will warp. The thickness depends upon the job itself. Pinch dogs should be used while gluing, or nail if stock is heavy enough. Some form of clamp should be used on the segments. In turning jobs, true up faceplate and scribe center line in lathe. Then build on stock ready for turning. It is not necessary to have nails in segments when the drawings are being sawed out, etc.

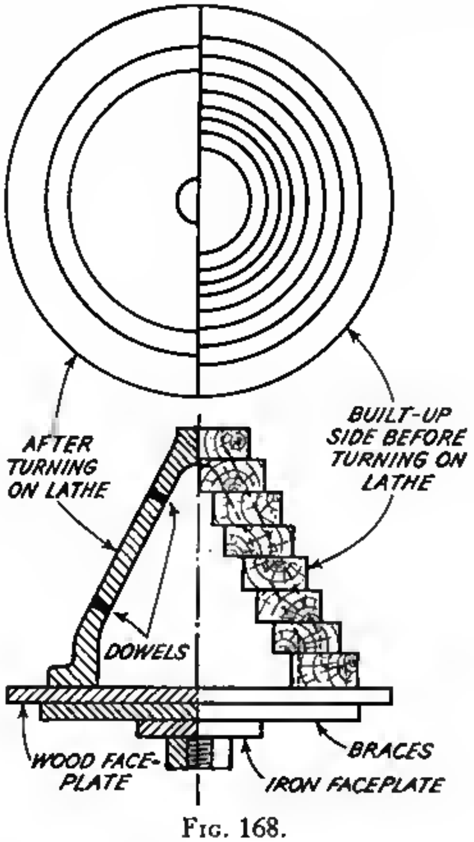


Fig. 168.

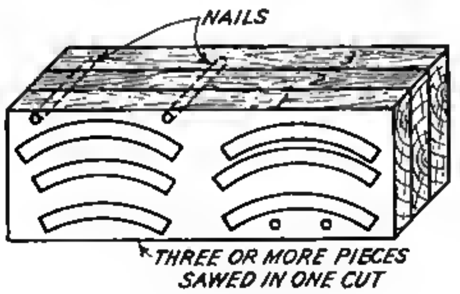
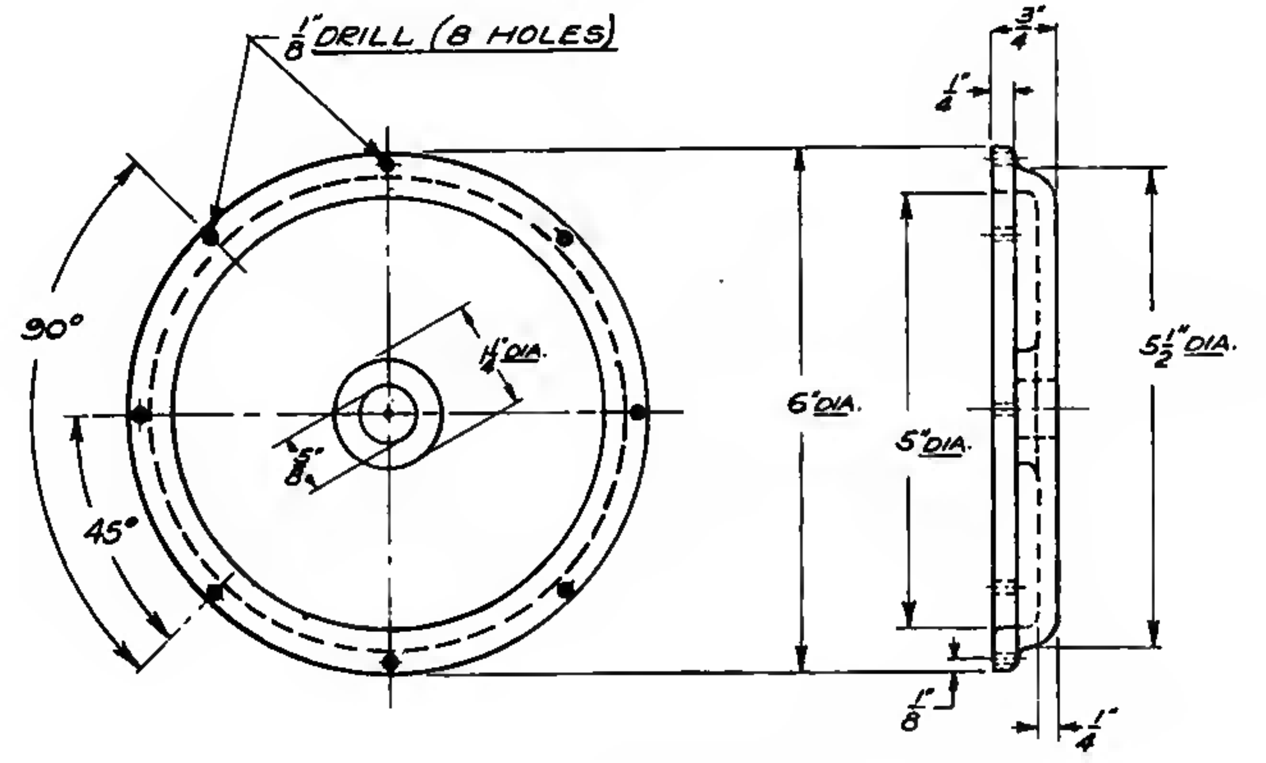


Fig. 169.

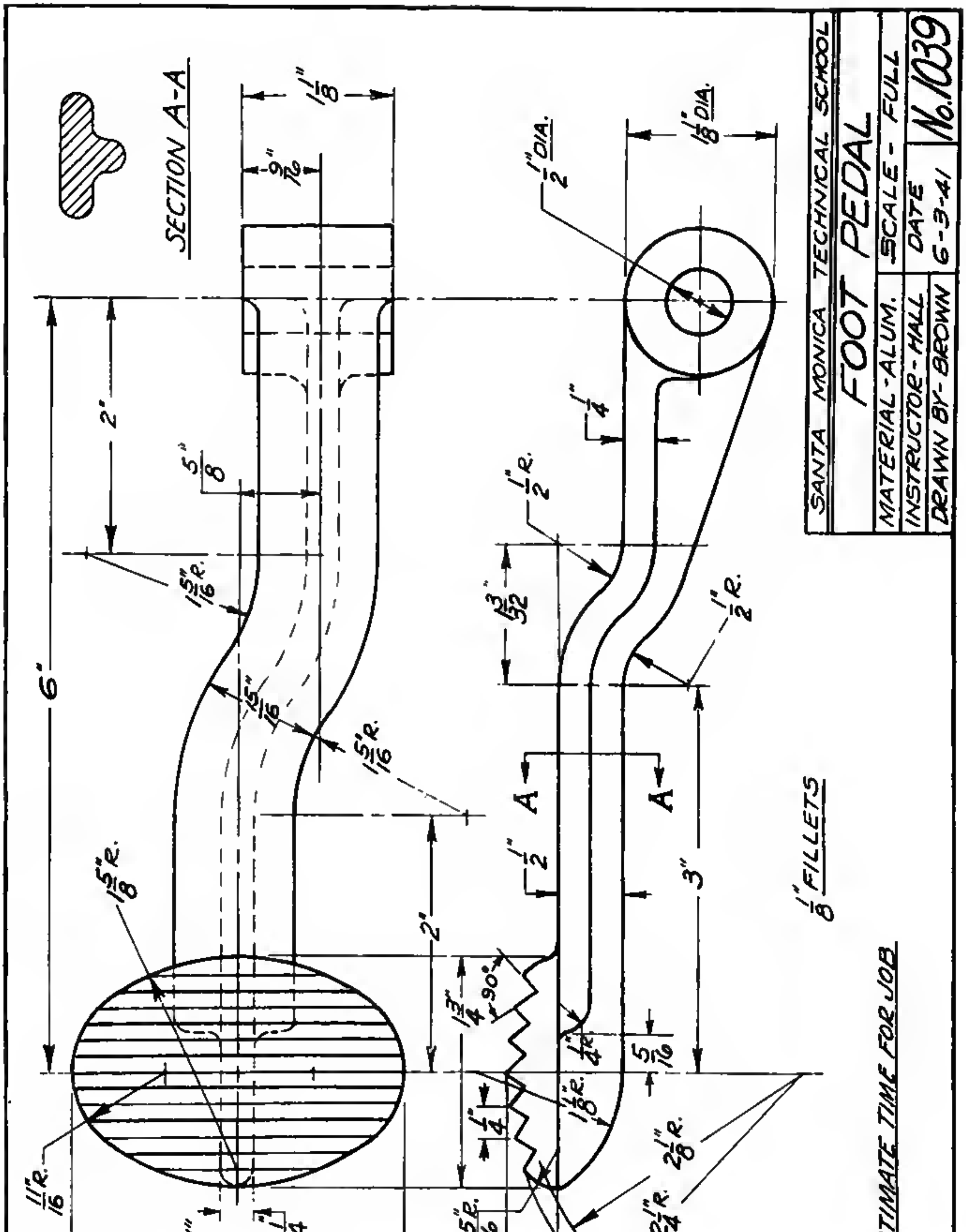


1/8" FILLETS

NOTE:
MAKE IN SEGMENTS

5 HRS.

SANTA MONICA TECHNICAL SCHOOL		
OIL PAN		
MATERIAL - ALUMINUM	SCALE - HALF SIZE	
INSTRUCTOR - HALL DRAWN BY - BROWN	DATE 5-31-41	No 1038



SANTA MONICA TECHNICAL SCHOOL
FOOT PEDAL
MATERIAL - ALUM.
SCALE - FULL
INSTRUCTOR - HALL
DATE 6-3-41
DRAWN BY - BROWN
No. 1039
SECTION A-A
1/8" FILLETS
ESTIMATE TIME FOR JOB

59. HOW TO MOLD PATTERNS WITH LOOSE PIECES

1. Ram up the pattern in the ordinary way (drag first); then before striking off, dig down and pull out the nail that holds the loose piece.
2. Fill in the space dug out and strike off.
3. Turn over and proceed in the same manner with the cope.
4. After the cope is lifted off and the pattern drawn out, reach in the mold with a hooked scriber and draw back the loose piece and take it out.
5. Cut the gates; place cores, if any; clean the face of the mold; replace the cope.

Some sample patterns with loose pieces are illustrated on page 114.

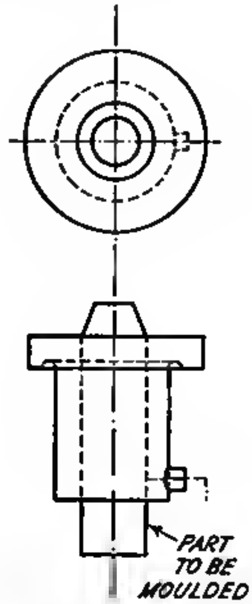


Fig. 170.

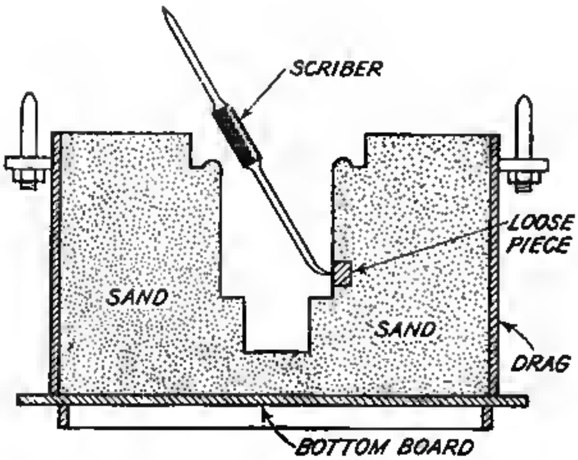


Fig. 171.

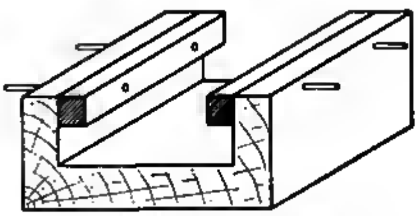


Fig. 172.

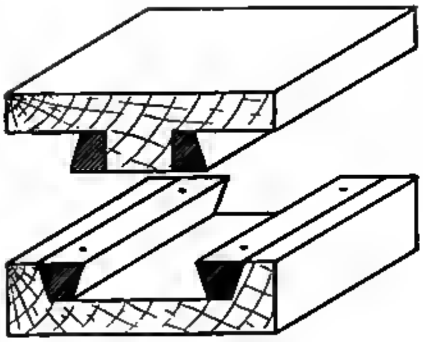


Fig. 173.

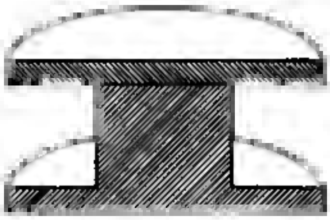


Fig. 174.

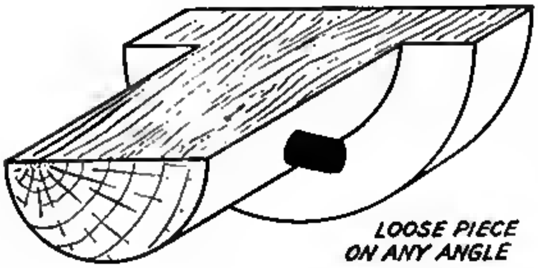


Fig. 175.

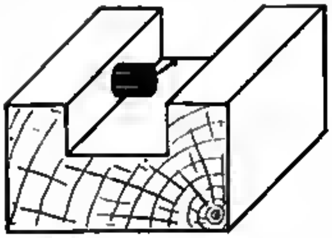


Fig. 176.

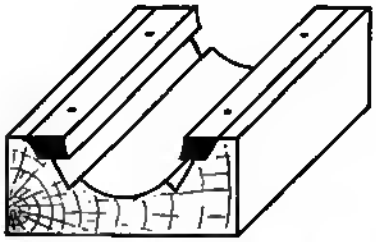


Fig. 177.

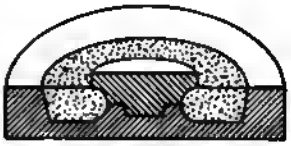
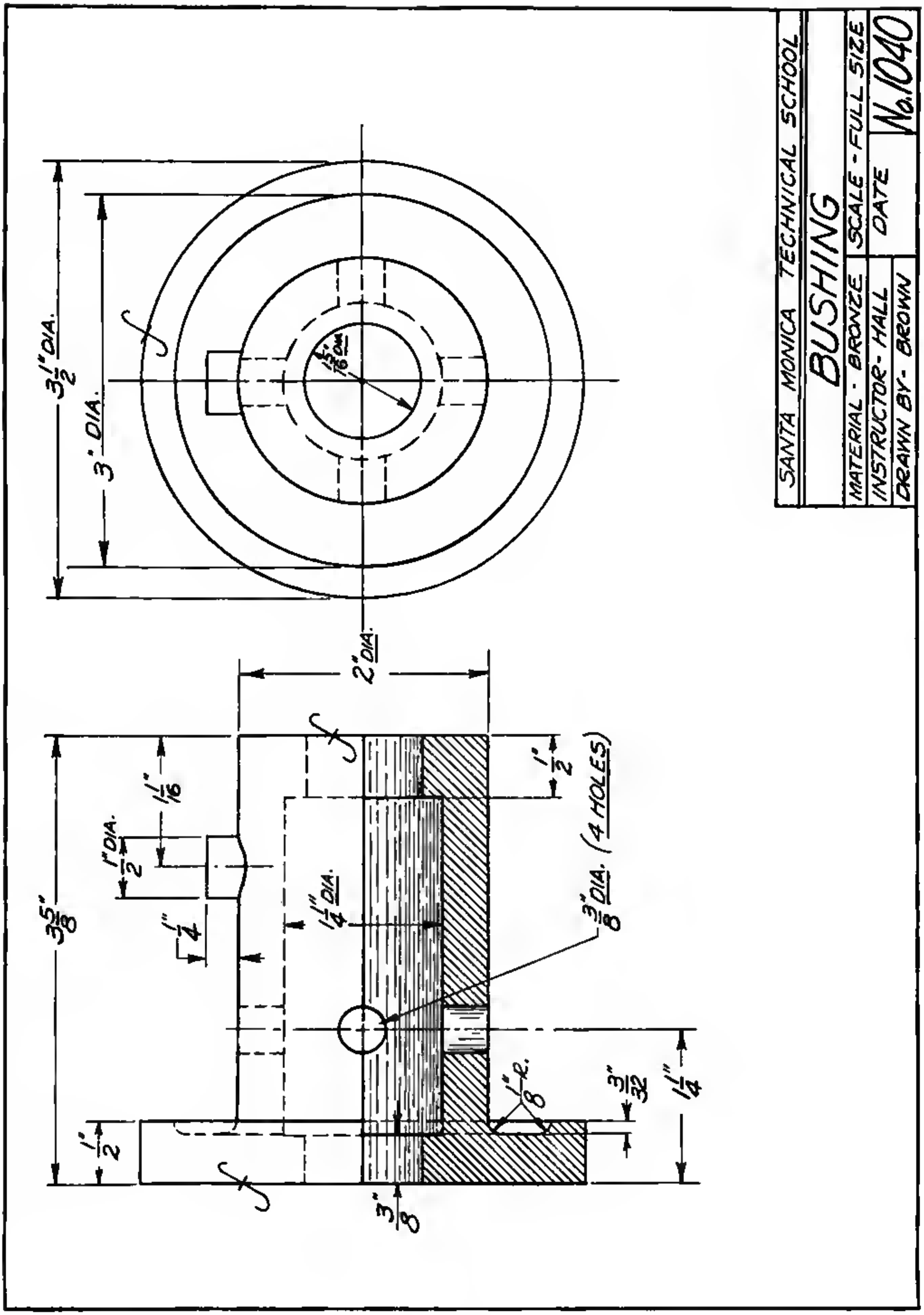


Fig. 178.


SANTA MONICA TECHNICAL SCHOOL
BUSHING
MATERIAL - BRONZE
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE
DRAWN BY - BROWN
No.1040
3 1/2" DIA.
3" DIA.
2" DIA.
1 1/4" DIA.
3/8" DIA. (4 HOLES)
1/2" DIA.

60. HOW TO MOLD ONE-PIECE PATTERNS WITH DRY SAND CORE

1. Lay the pattern (Fig. 179) on the board, drag side up, with the cope print removed.
2. Dust the pattern with parting sand, and set the drag on the board with pins down.
3. Riddle in sand to cover the pattern; then fill up and ram edges.
4. When they are thoroughly rammed, strike off (Fig. 180).
5. Put the board on and turn it over, holding the flask and both boards together.
6. Remove top board, put on cope print, set on the cope, set sprue and riser pins, and dust.
7. Riddle in sand, fill, ram, and strike off as on the drag side.
8. Pull out the sprue and riser pins and round the edges, eliminating loose sand around the holes.
9. Pick off the cope carefully and set it on edge.
10. Drive a pin in the pattern, rap, and draw it out slowly. Be careful not to touch the sides of the mold with the pattern.
11. Cut the gates to the sprue and riser; blow all loose sand from the face of the mold.
12. Set the dry sand core in place, and replace the cope (Fig. 182).

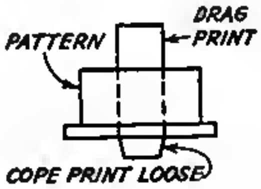


Fig. 179.

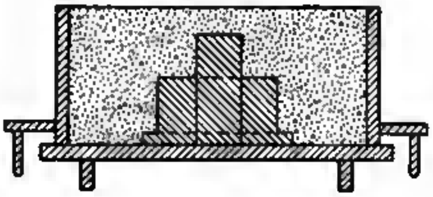


Fig. 180.

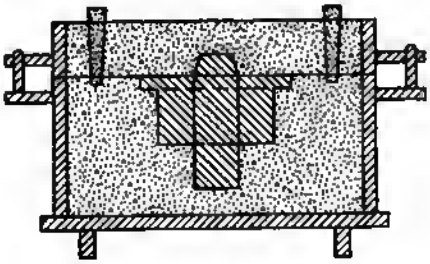


Fig. 181.

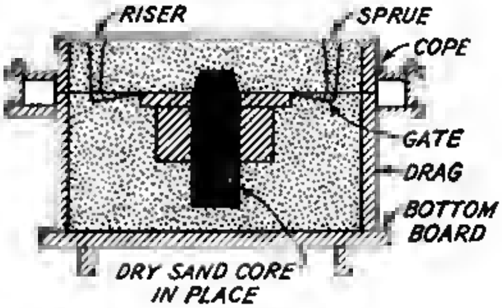


Fig. 182.

61. HOW TO MOLD PATTERN WITH COVER CORE

1. Ram up drag half of pattern, strike off, put on board, and turn over.
2. Put on cope half of pattern, put on cope. Next set sprue and riser pins, dust, ram up, and strike off.
3. Pull sprue and riser pins and then round.
4. Dig down in cope and draw out loose print and flange carefully. Place round cover core, then fill in with sand on top of cover core. Press in with hand only.
5. Put on bottom board and lift off cope. Draw out pattern, both cope and drag.
6. Cut gates, set big core, and replace cope.

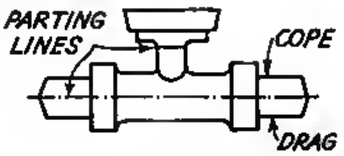


Fig. 183.

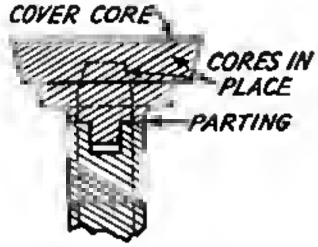


Fig. 184.

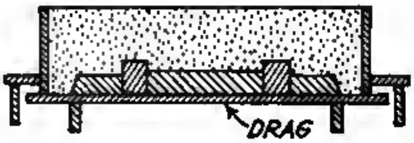


Fig. 185.

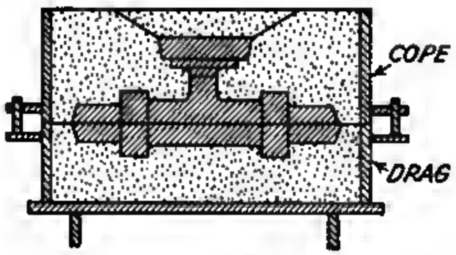


Fig. 186.

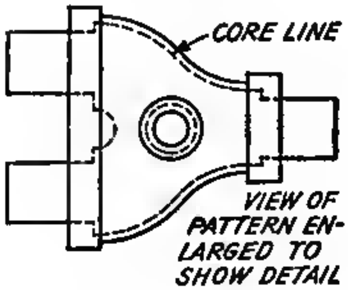


Fig. 187.

62. HOW TO USE BABBITT ANCHORS

Castings that have a babbitt bearing require an anchor to hold the babbitt in place. *Babbitt anchor* is the term usually given to the cutout made on the pattern or core box.

The construction of such a core box using a cover core is shown in Fig. 188. Note the loose piece above the cutout. This is made so that the core can be dumped out on the core plate and the loose pieces picked off the core.

In some cases it may be necessary to put the loose pieces on the pattern. In such an event, the pieces would have to be pulled back and then lifted out, using no core box (Fig. 189).

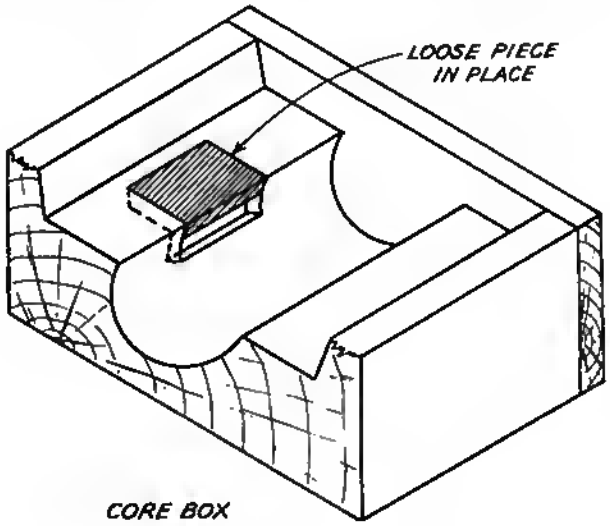


Fig. 188.

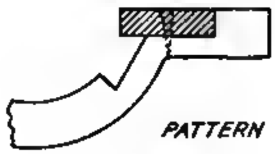
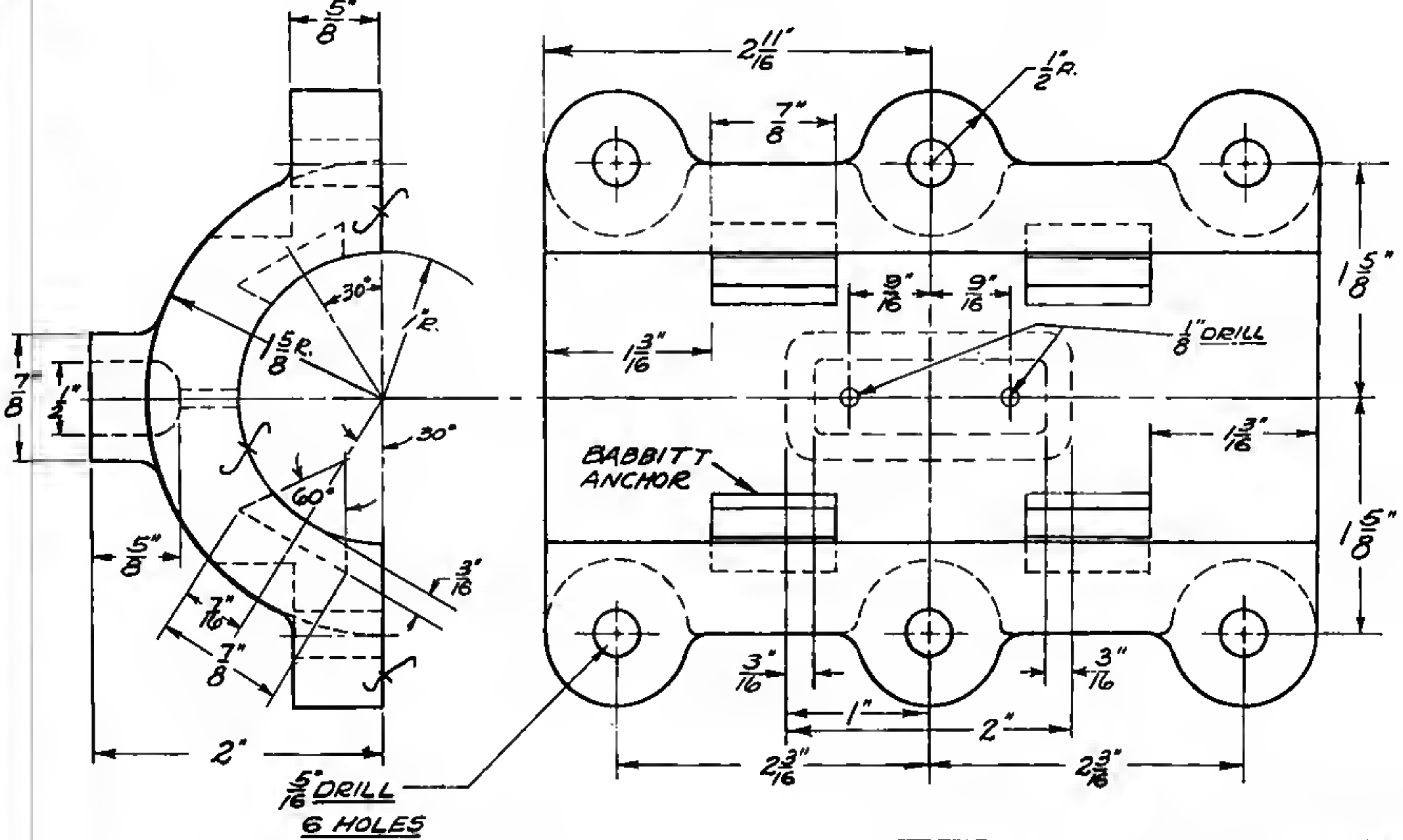


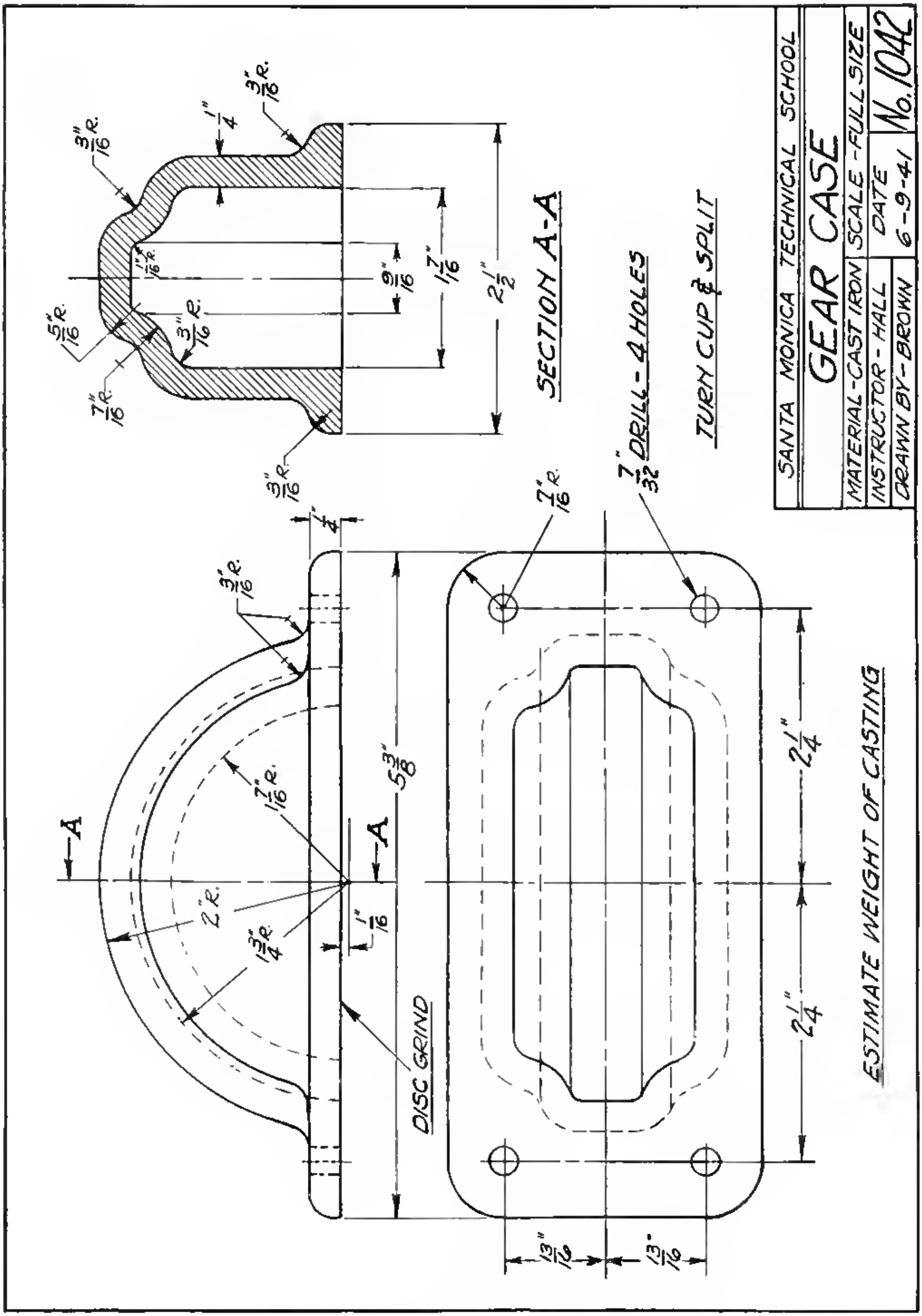
Fig. 189.

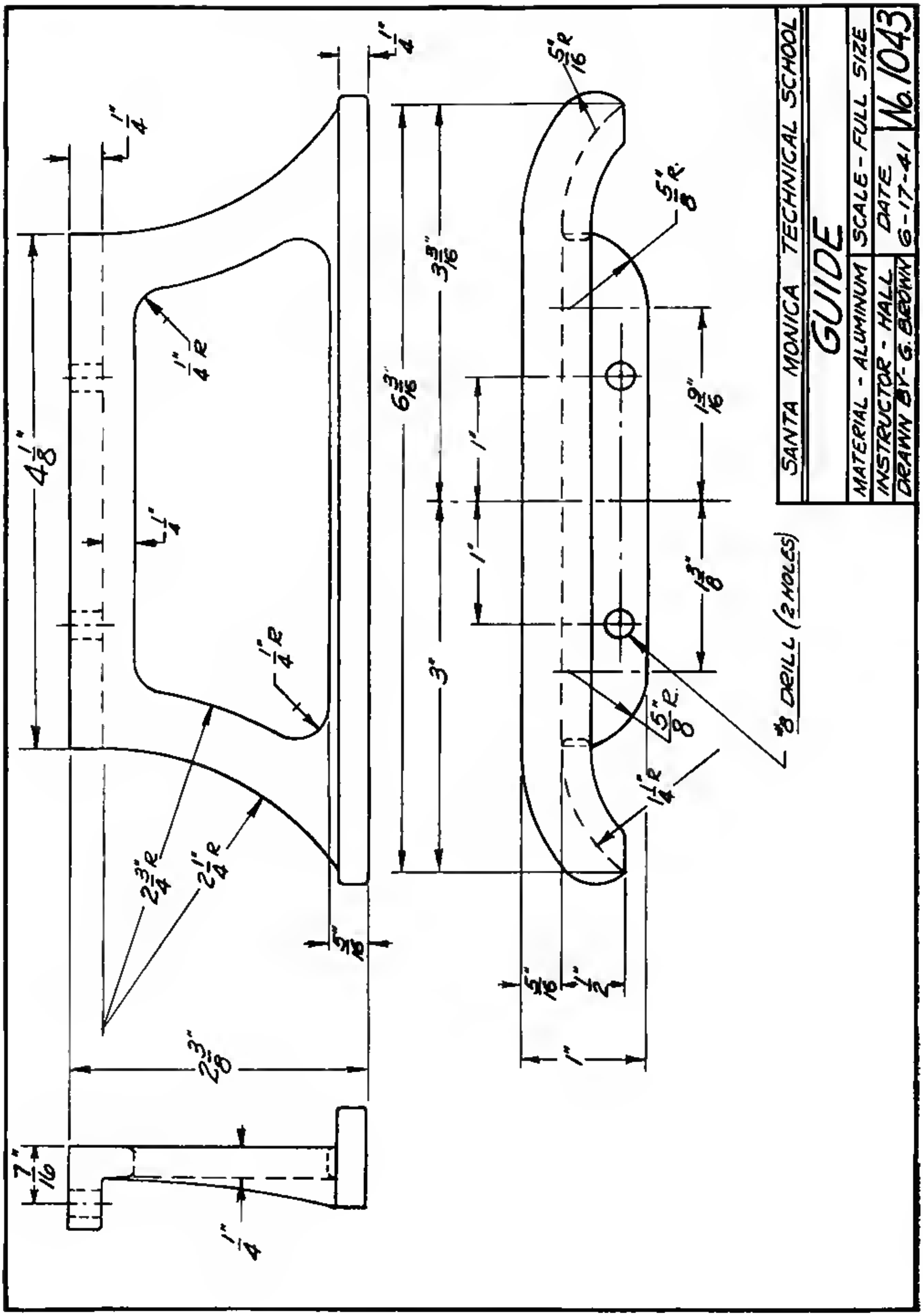


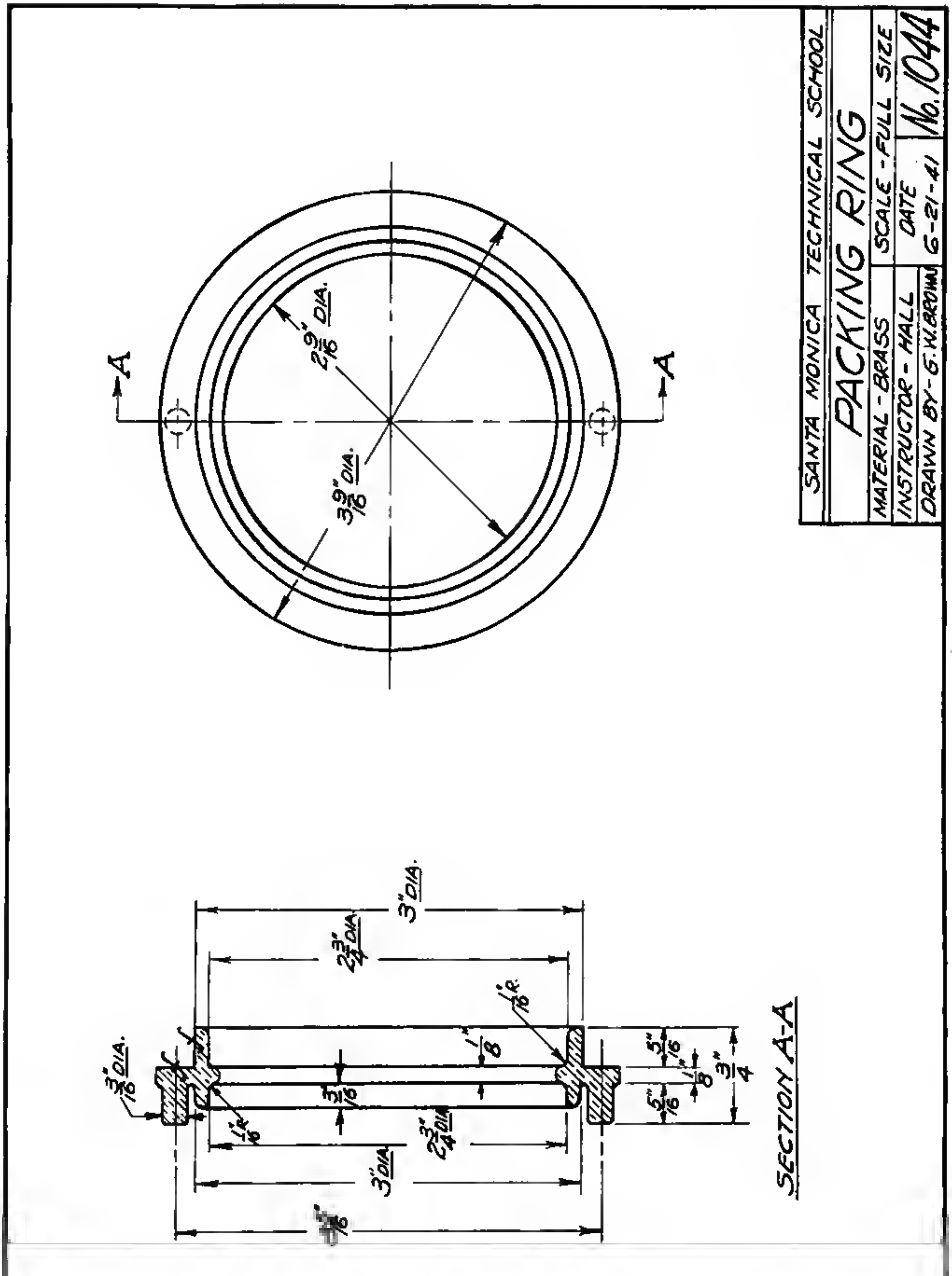
SANTA MONICA TECHNICAL SCHOOL

BEARING CAP

MATERIAL - CAST IRON | SCALE - FULL SIZE
INSTRUCTOR - HALL | DATE 6-11-41 | No. 1041
DRAWN BY - BROWN


SANTA MONICA TECHNICAL SCHOOL
GEAR CASE
MATERIAL-CAST IRON
SCALE-FULL SIZE
INSTRUCTOR-HALL
DATE 6-9-41
DRAWN BY-BROWN
No. 1042
SECTION A-A
7/32" DRILL-4 HOLES
TURN CUP & SPLIT
ESTIMATE WEIGHT OF CASTING
DISC GRIND


SANTA MONICA TECHNICAL SCHOOL
GUIDE
MATERIAL - ALUMINUM
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 6-17-41
DRAWN BY - G. BROWN
No. 1043
#8 DRILL (2 HOLES)



SANTA MONICA TECHNICAL SCHOOL
PACKING RING
MATERIAL - BRASS
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 6-21-41
DRAWN BY - G. W. BROWN
No. 1044
A
A
$2\frac{9}{16}$" DIA.
$3\frac{9}{16}$" DIA.
SECTION A-A
3" DIA.
$2\frac{3}{4}$" DIA.
$\frac{1}{16}$" R.
$\frac{1}{8}$"
$\frac{3}{16}$"
$\frac{5}{16}$"
$\frac{3}{4}$"
$\frac{3}{16}$" DIA.

63. HOW TO USE PLUGGED CORE HOLES

A curved-flange pattern (Fig. 190) is made differently from a straight-flange pattern. With such a design, all the flange holes are made with a plug, since it is very difficult to draw out the pattern from the sand with core prints.

The holes are made in the pattern about $\frac{1}{32}$ in. larger in diameter than is called for on the blueprint. A plug is then turned to the exact size of the diameter of the holes wanted, enabling it to rest fairly loosely in each hole. It should have a stop on one end and taper slightly, as a core print is on the other end (Fig. 191).

The pattern is rammed up in the regular way. After the cope is lifted off, this plug is pushed through each hole in the flange to the stop on the plug. Each hole in the drag thus has the same depth. The pattern is then drawn out and small cores, known as *stub cores* (Fig. 192), are placed in the holes, the top of the cores coming flush with the face of the mold.

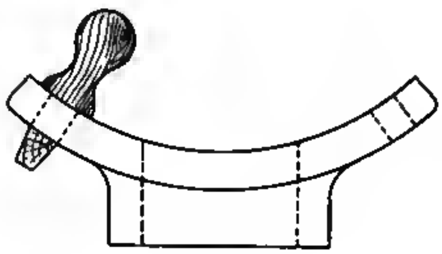


FIG. 190.

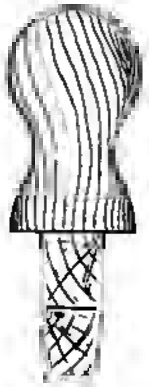


FIG. 191.

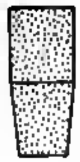
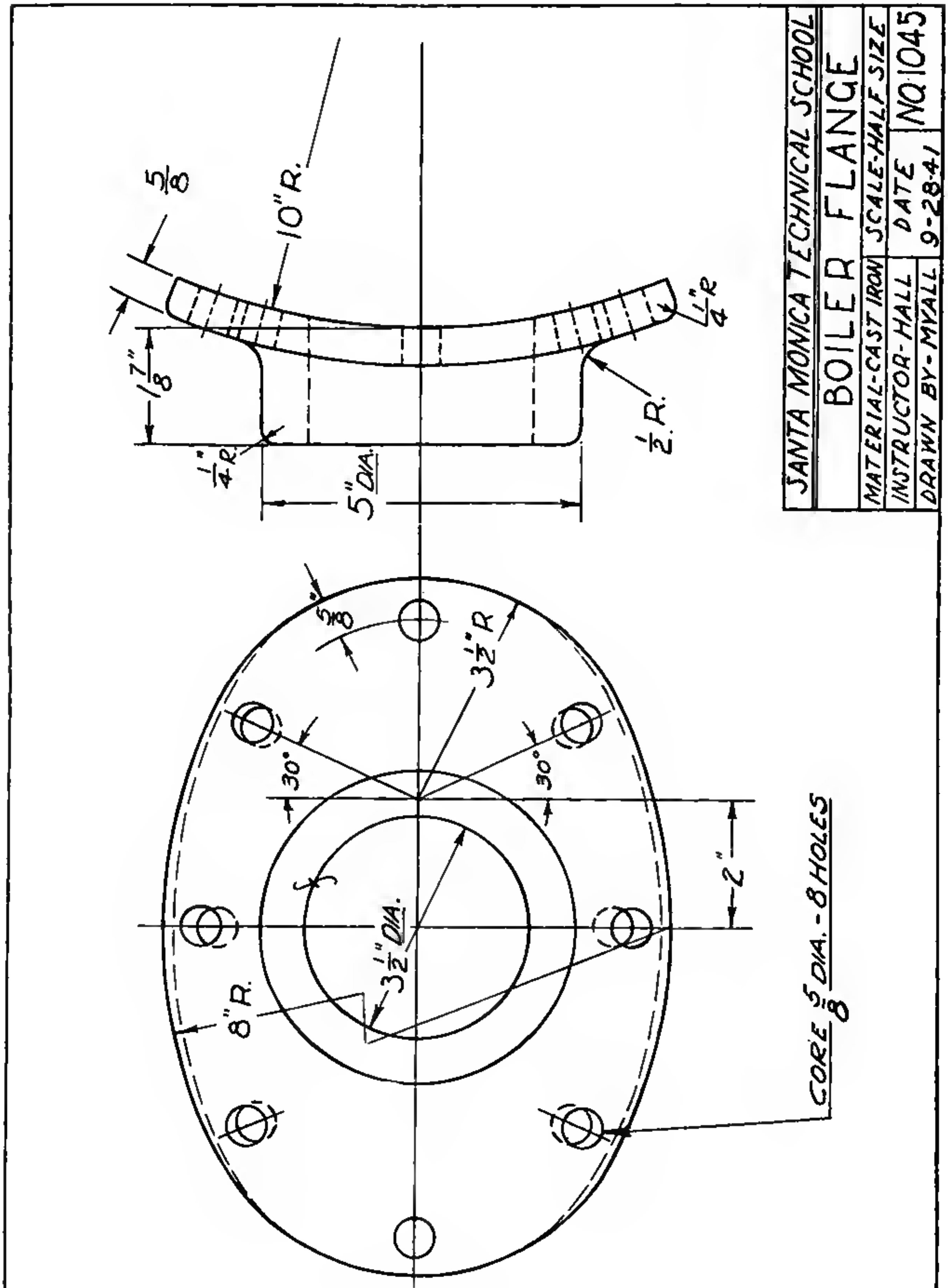


FIG. 192.



SANTA MONICA TECHNICAL SCHOOL
BOILER FLANGE
MATERIAL-CAST IRON
SCALE-HALF SIZE
INSTRUCTOR-HALL
DATE 9-28-41
DRAWN BY-MYALL
NO.1045
5/8
10" R.
1 7/8"
1/4" R
1/2 R.
1/4" R.
5" DIA.
5/8
3 1/2" R
30°
30°
2"
8" R.
3 1/2" DIA.
CORE 5/8 DIA.-8 HOLES

64. HOW TO MAKE CORES FOR A ONE-CASTING JOB

In some cases molders may make their own cores in an emergency or in a one-casting job. It is not profitable, however, if many castings are to be made, since it makes extra work for the molder and increases the cost of the castings.

A grooved pulley (Fig. 193) may be molded in the following manner:

1. Ram up the drag half of the pattern, and turn it over as usual.
2. Dig the sand away all around the pattern to the bottom of the flange or groove. Smooth this sand with a slick and dust it well.
3. Place the cope half of the pattern on and fill in the groove, making a green sand core (Fig. 193). Dust this core well.
4. Ram up the cope and lift it off. Draw out the cope half of the pattern and replace cope.
5. Turn the whole mold over and lift off the drag. The weight of the green sand core will naturally cause it to stay in the cope which is on the bottom. Draw out the drag half of the pattern. Replace the drag, roll it over, lift off the cope, cut the gates, etc.

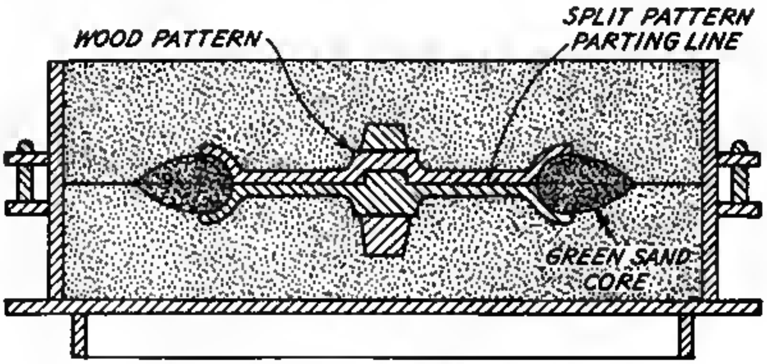


FIG. 193.

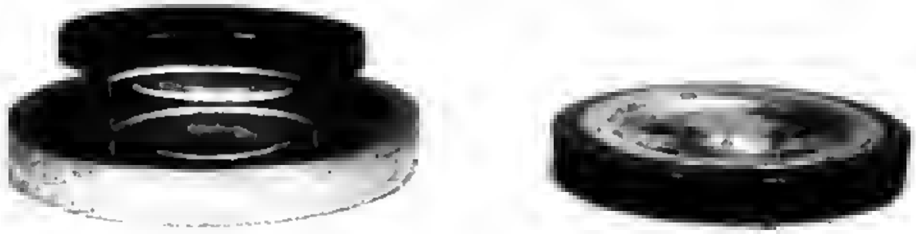
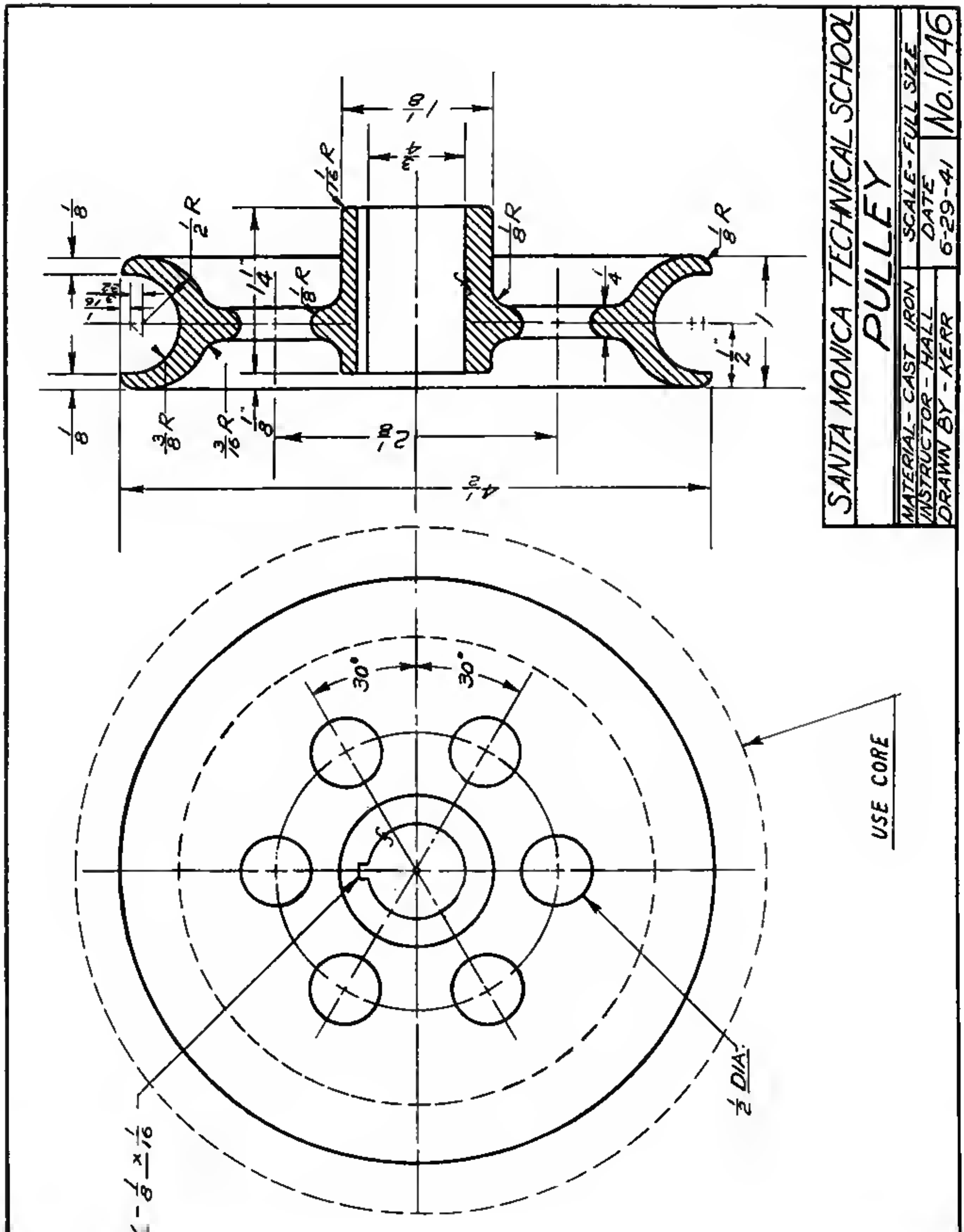
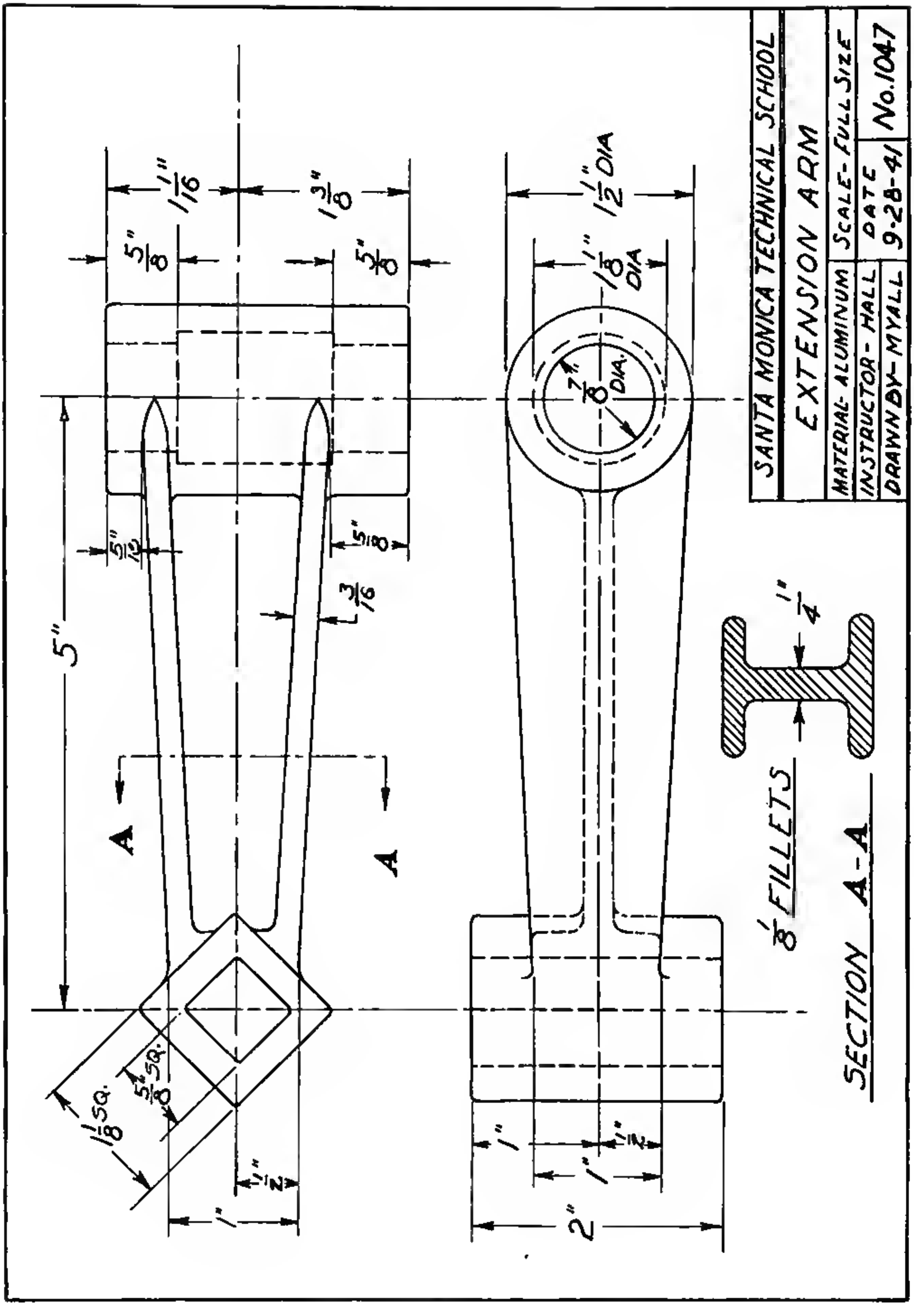


FIG. 194.—Pulley pattern 1046 may also be made as shown here.


SANTA MONICA TECHNICAL SCHOOL
PULLEY
MATERIAL - CAST IRON
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 6-29-41
DRAWN BY - KERR
No. 1046
USE CORE
1/2 DIA.
KEYWAY - 1/8 x 1/16
30°
30°


SANTA MONICA TECHNICAL SCHOOL
EXTENSION ARM
MATERIAL- ALUMINUM
SCALE- FULL SIZE
INSTRUCTOR- HALL
DATE 9-28-41
DRAWN BY- MYALL
No. 1047
1 1/16"
1 3/8"
5/8"
5/8"
1 1/2" DIA
1 1/8" DIA
7/8" DIA.
5/16"
5/8"
3/16
5"
1/4"
A
A
1/8" FILLETS
SECTION A-A
1 1/8 SQ.
5/8" SQ.
1/2"
1"
1"
1"
1/2"
2"

65. HOW TO JOIN STOCK

There are different methods of joining stock for patterns and core boxes. Each method should be used in its place. All joints should be fitted well before gluing or screwing together. The following are illustrated.

The **straight-edge** or **butt joint** is probably used most of all. When it is glued, it should be reinforced if possible by nails, screws, dowels, or cross ribs (Fig. 195).

The **lap joint,** if properly fitted and glued, is commonly and very satisfactorily used in the joining of webs and ribs (Fig. 196).

The **tongue-and-groove joint** is often used in the making of boards for mounting patterns in plate work (Fig. 197).

The **splined joint** may be used in the gluing up of wide boards edgewise. A cross grain or 45-deg. spline should be used for the best results (Fig. 198).

The **rabbet** or **dado joint** is easily made and frequently used on such work as the sides and ends of core boxes (Fig. 199).

The **mortise and tenon joint** is used in some pattern framework but very little in small pattern work (Fig. 200).

The **dovetail joint** is used sometimes on loose pieces for first-class patterns and core boxes. Although it is very satisfactory, it is slow and takes more time than other types (Fig. 201).

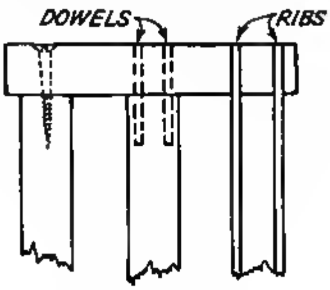


FIG. 195.

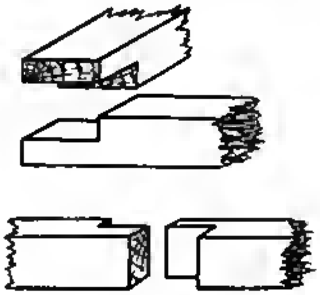


FIG. 196.

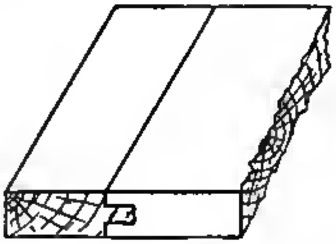


FIG. 197.

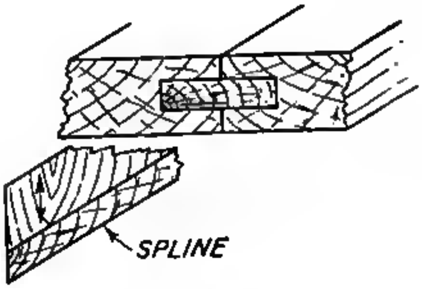


FIG. 198.

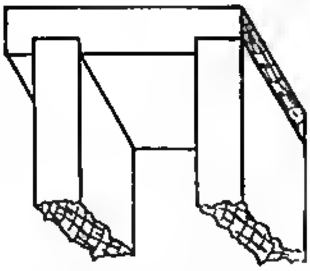


FIG. 199.

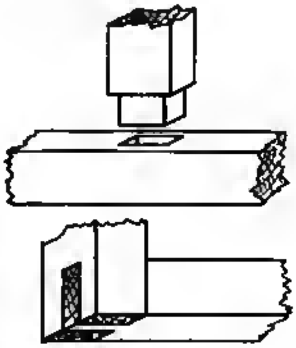


FIG. 200.

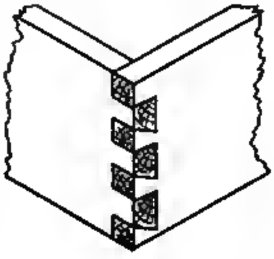
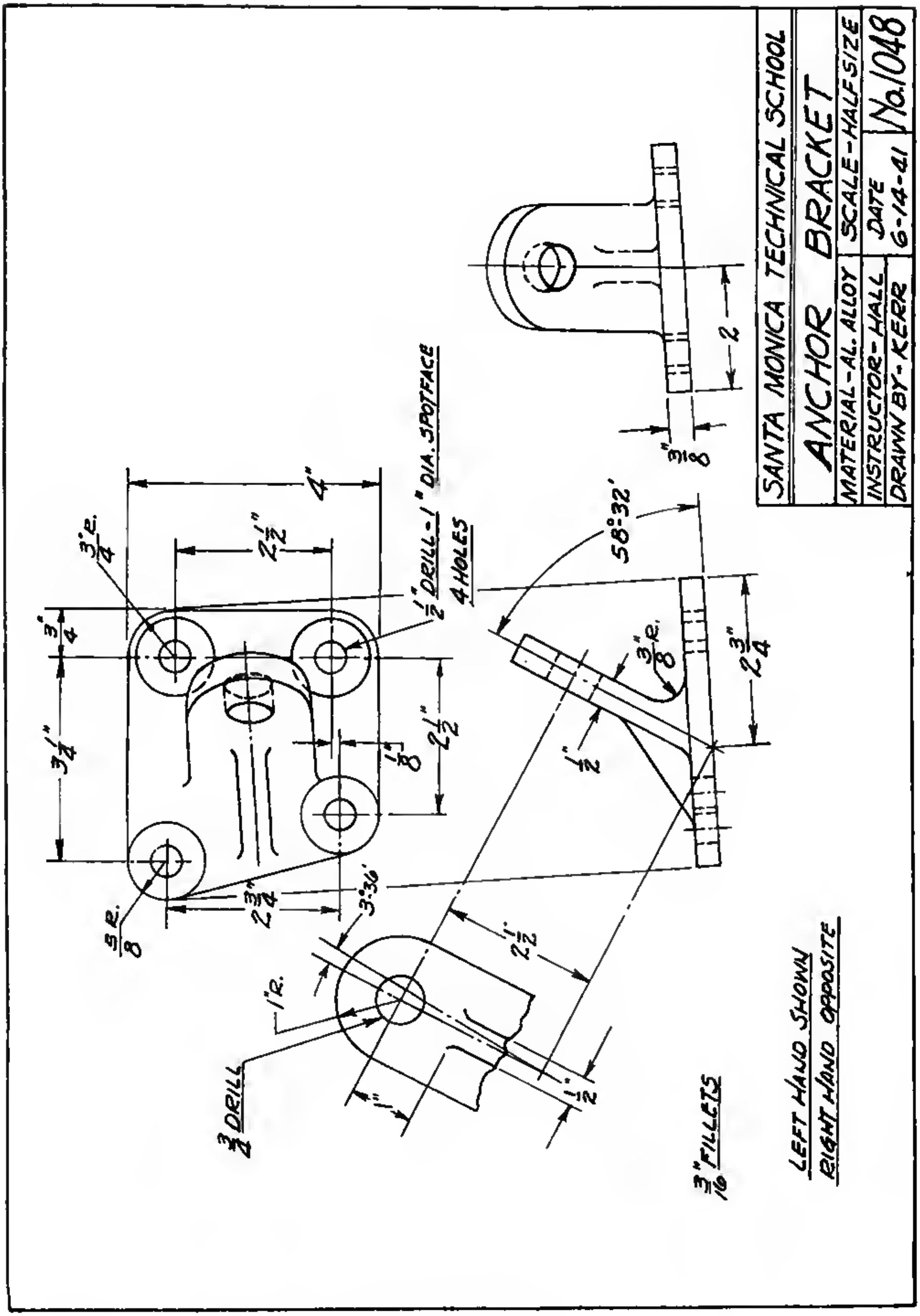


FIG. 201.


SANTA MONICA TECHNICAL SCHOOL
ANCHOR BRACKET
MATERIAL-AL. ALLOY
SCALE-HALF SIZE
INSTRUCTOR-HALL
DATE 6-14-41
DRAWN BY-KERR
No. 1048
1/2" DRILL-1" DIA. SPOTFACE
4 HOLES
58°32'
3°36'
3/4 DRILL
3/16" FILLETS
LEFT HAND SHOWN
RIGHT HAND OPPOSITE

66. HOW TO MOUNT SMALL PATTERNS ON BOARD

When many small castings are to be made alike, or when a complete set of small castings is wanted, they are mounted on a board. The face of this board is the parting line of the pattern. Some patterns will be made split, with one half placed on each side of the board, while others may be placed on one side only depending upon the shape of the pattern. The runners and gates are mounted on the board with the patterns. This is a timesaver for the molder, as he can draw a set or a dozen small patterns on a board as easily as one lone pattern.

After the mold is opened and the board lifted off, the cores are set in place if any are needed and the mold is closed ready for pouring. With the drag half of the pattern on one side of the board and the cope half on the other side, great care should be taken to get the center lines exactly opposite each other. This type of work must be absolutely accurate because if the lines vary 1/64 in., in reality there is an error of 1/32 in. on the whole set, or 1/64 in. each way.

Study Figs. 206 and 207.

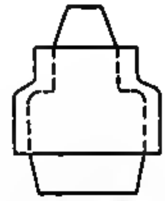


FIG. 202.

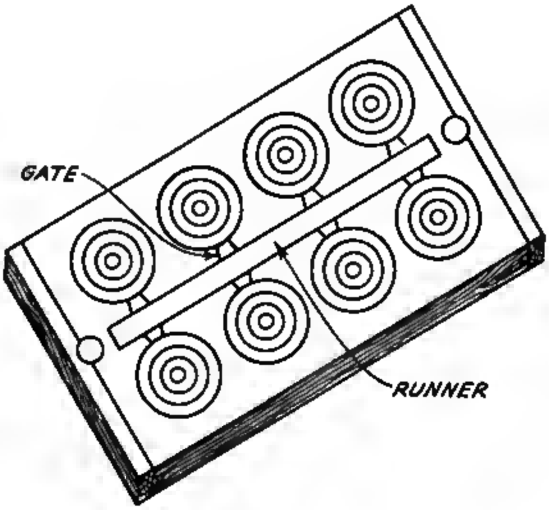


FIG. 203.

FIG. 204.

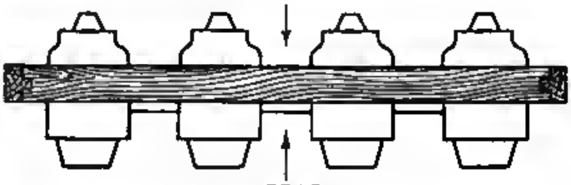


FIG. 205.

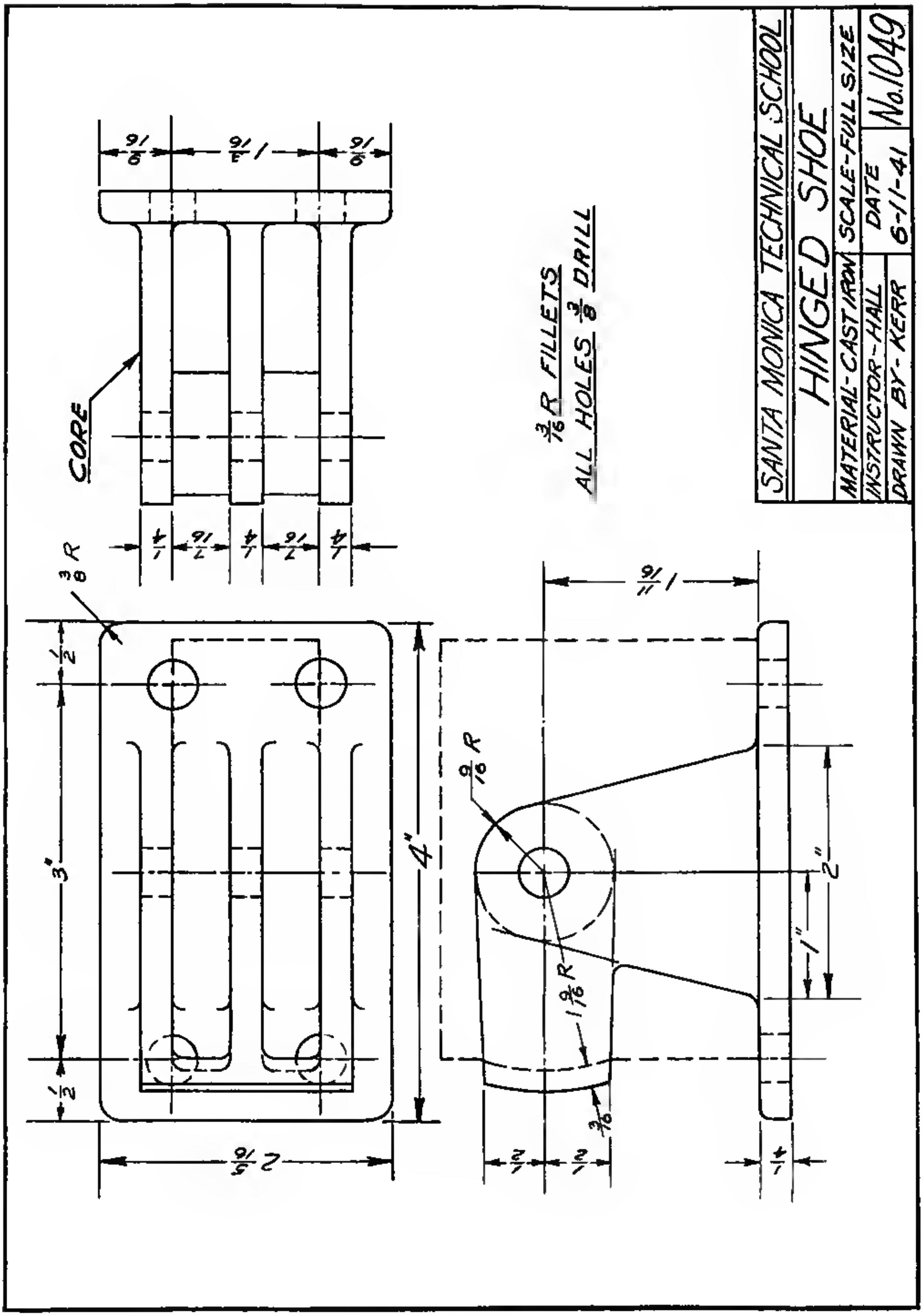
FIG. 206.

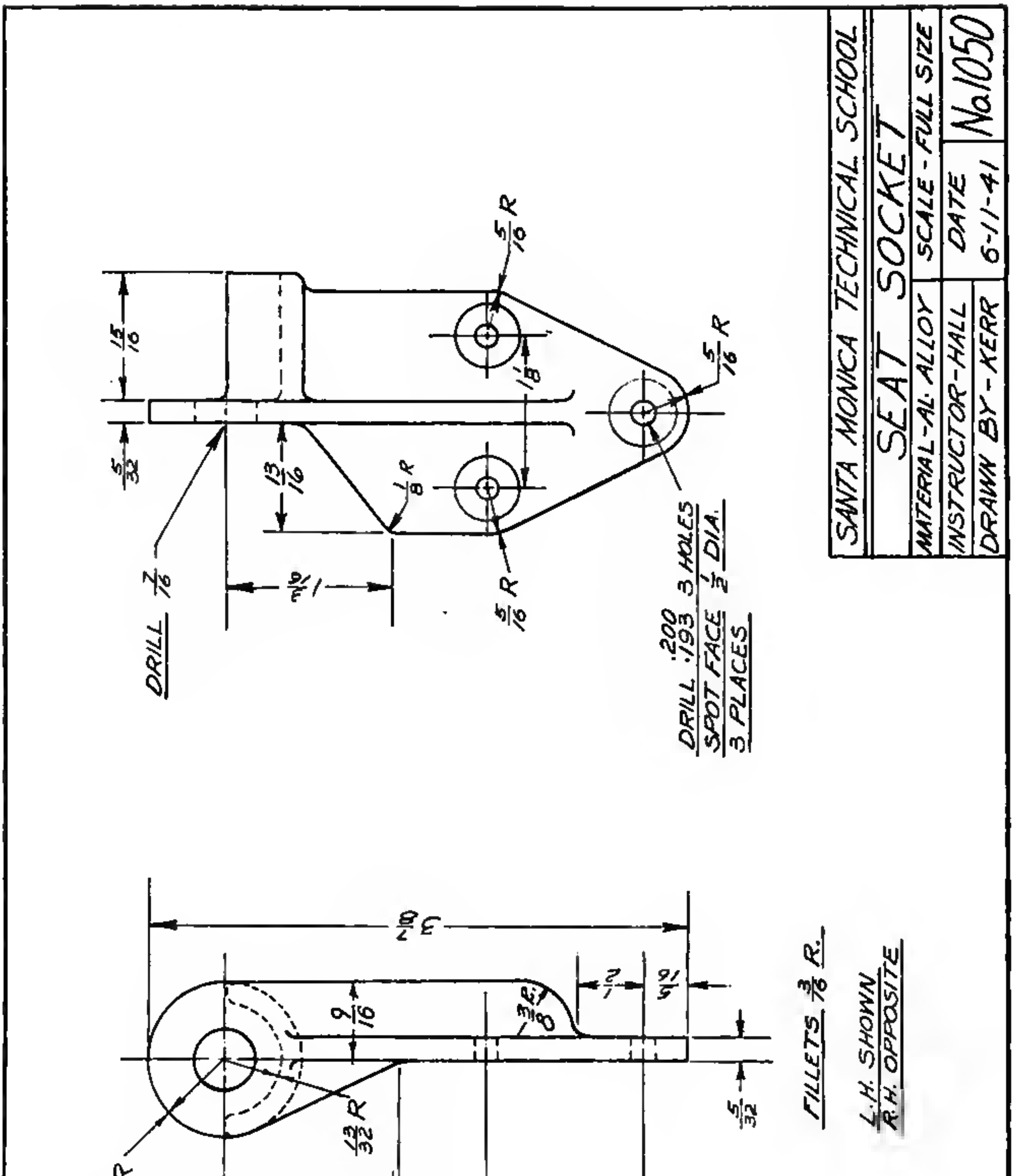
FIG. 207.

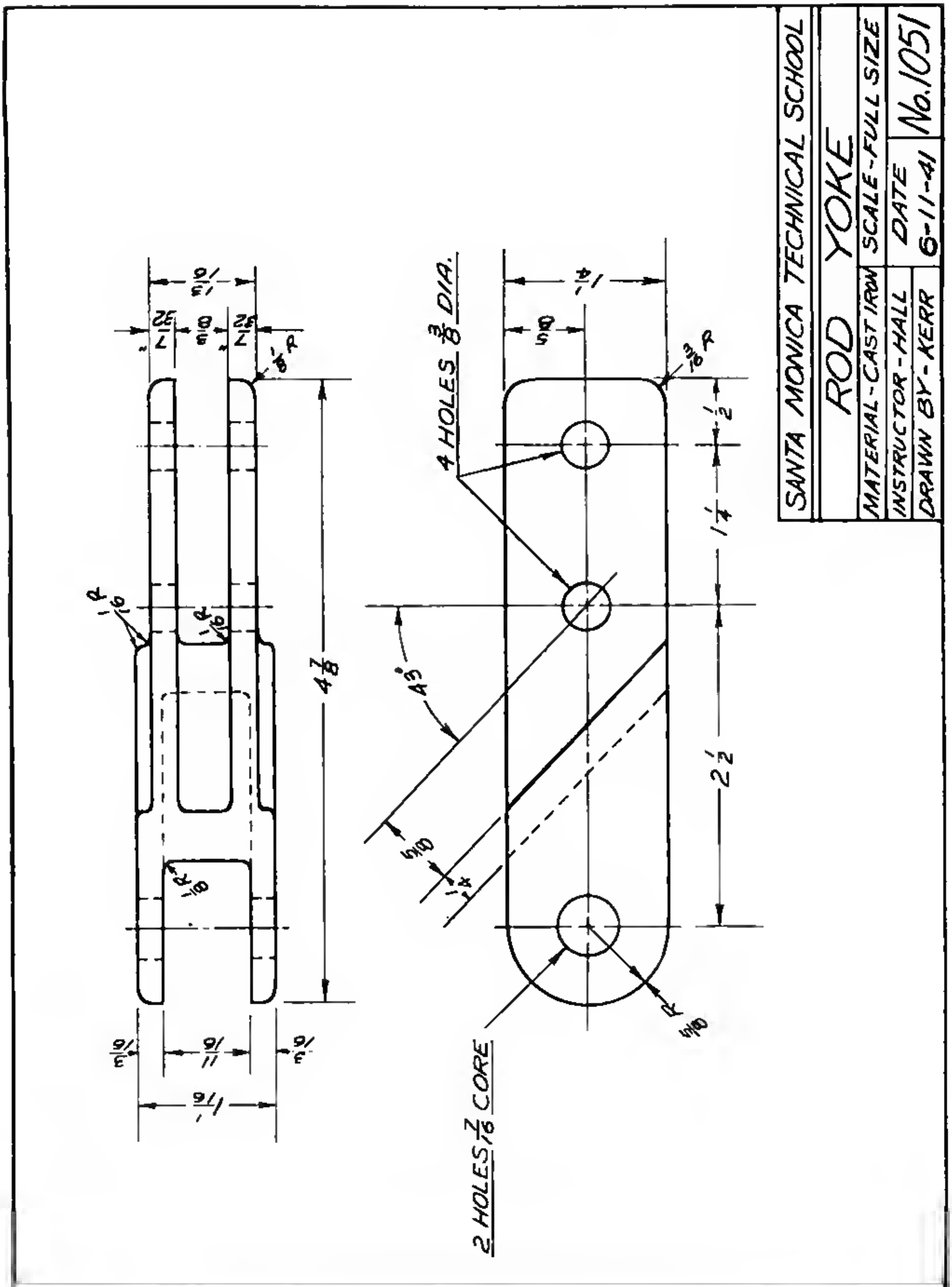
67. HOW TO MAKE PATTERN FROM BLUEPRINT 1049

A pattern with a double opening or three brackets as in blueprint 1049 should be made a solid pattern and molded on its side with a core print, as indicated by dotted lines on the print.

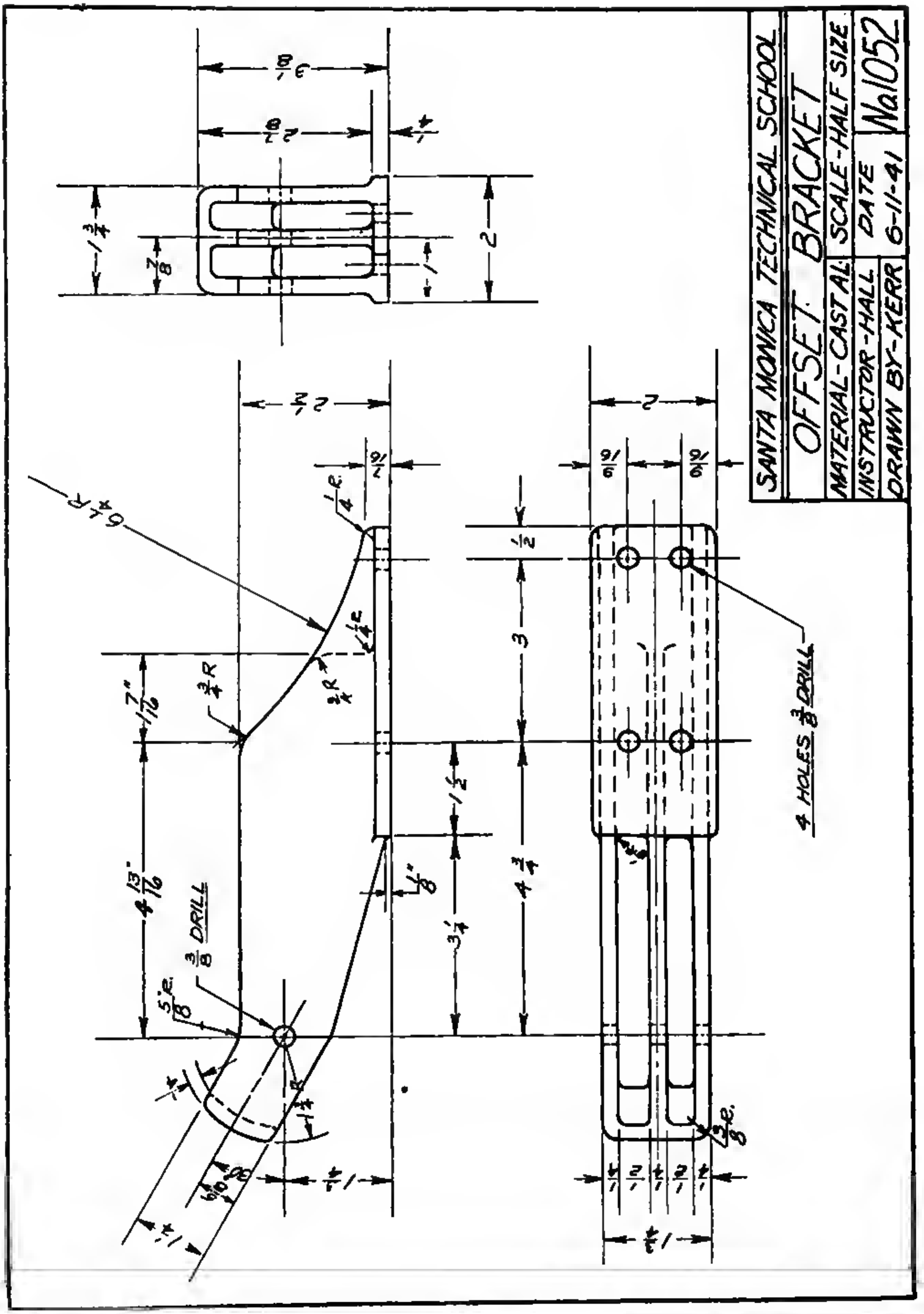
Two core boxes should be made. One core should be $7/16$ in. thick and the other $7/16$ plus $1/4$, or $11/16$ in. thick, with this center bracket lying in the bottom of the core box. The two cores should be made and pasted together, then set together.


SANTA MONICA TECHNICAL SCHOOL
HINGED SHOE
MATERIAL-CAST IRON
SCALE-FULL SIZE
INSTRUCTOR-HALL
DATE 6-11-41
DRAWN BY-KERR
No. 1049
3/16 R FILLETS
ALL HOLES 3/8 DRILL
CORE
3/8 R
9/16 R
1 9/16 R
2 5/16
1 11/16
1 3/16
4"
3"
2"
1"


SANTA MONICA TECHNICAL SCHOOL
SEAT SOCKET
MATERIAL-AL. ALLOY
SCALE - FULL SIZE
INSTRUCTOR-HALL
DATE 6-11-41
DRAWN BY-KERR
No.1050
DRILL 7/16
DRILL .200/.193 3 HOLES
SPOT FACE 1/2 DIA.
3 PLACES
FILLETS 3/16 R.
L.H. SHOWN
R.H. OPPOSITE



SANTA MONICA TECHNICAL SCHOOL
ROD YOKE
MATERIAL-CAST IRON
SCALE-FULL SIZE
INSTRUCTOR-HALL
DATE 6-11-41
DRAWN BY-KERR
No. 1051
4 HOLES 3/8 DIA.
2 HOLES 7/16 CORE
45°
4 7/8
2 1/2
1 1/4
1/2
3/16 R
1/8 R
1/16 R
5/16
1/4
13/16
7/32
11/16
3/16
1 1/16


SANTA MONICA TECHNICAL SCHOOL
OFFSET BRACKET
MATERIAL-CAST AL.
SCALE-HALF SIZE
INSTRUCTOR-HALL
DATE
6-11-41
DRAWN BY-KERR
No.1052
4 HOLES 3/8 DRILL
3/8 DRILL

68. HOW TO SPACE A BOARD IN EQUAL PARTS

A simple and quick way of spacing a board in equal parts is shown in Figs. 208 and 209. For example, if a 7½-in. board is to be spaced into five equal parts, the scale should be laid on the board at an angle so that the end is on one edge and number 10, or any multiple of 5, is on the other edge. Then the five divisions may be marked in.

This method is used many times in the lumber room to estimate or get approximate widths of a certain board before the board comes into the pattern shop. This same rule may be used in laying out equal spaces for placing ribs on patterns, or spacing screws, etc.

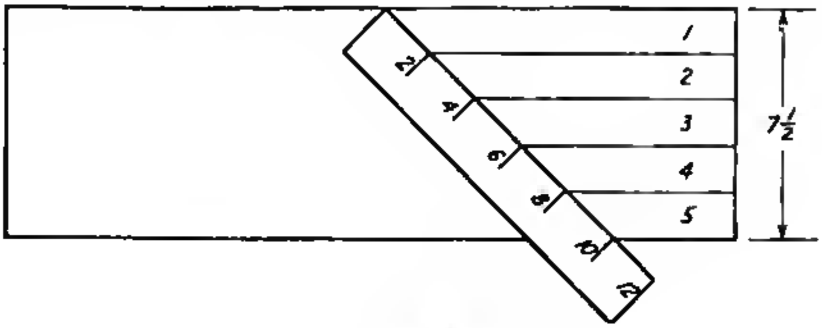


Fig. 208.

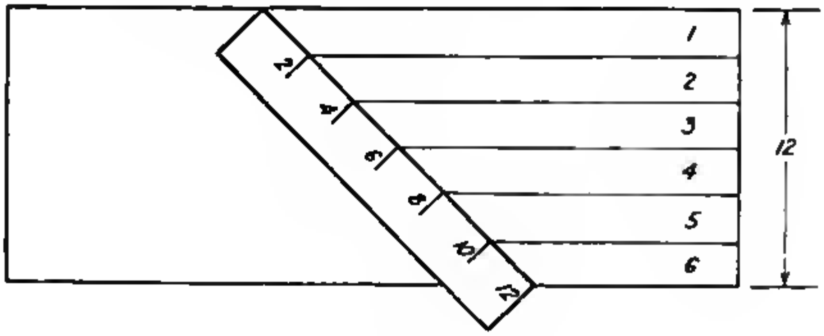


Fig. 209.

69. HOW TO USE RAPPING AND LIFTING PLATES

In small pattern work the molder has a sharp lifting pin which he drives into the pattern. He raps on its sides to loosen the pattern in the sand and draw it out.

If this practice were used in large patterns, the pin would be so large that the continued rapping would soon split and ruin the pattern for further use. So, of necessity, a rapping plate made of malleable iron cast in many sizes for different weights of patterns is used. These plates are set flush into the parting of the pattern. Smaller plates having two holes are screwed to the pattern. One hole is threaded for the lifting pin to screw into, and the other is smooth for a rapping hole.

Before this plate is set in, drill in for clearance under the threaded hole, which is on the lifting side. The threaded hole should be set over the center of gravity, which is not necessarily the center of the pattern.

Larger patterns should have a plate at each end so the molder can use both hands while lifting. Patterns that are drawn out with a crane should have four large plates set in with long, heavy screws (Fig. 210).

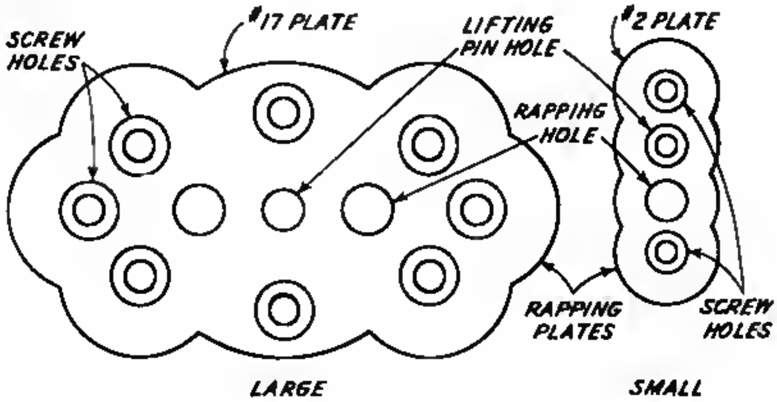
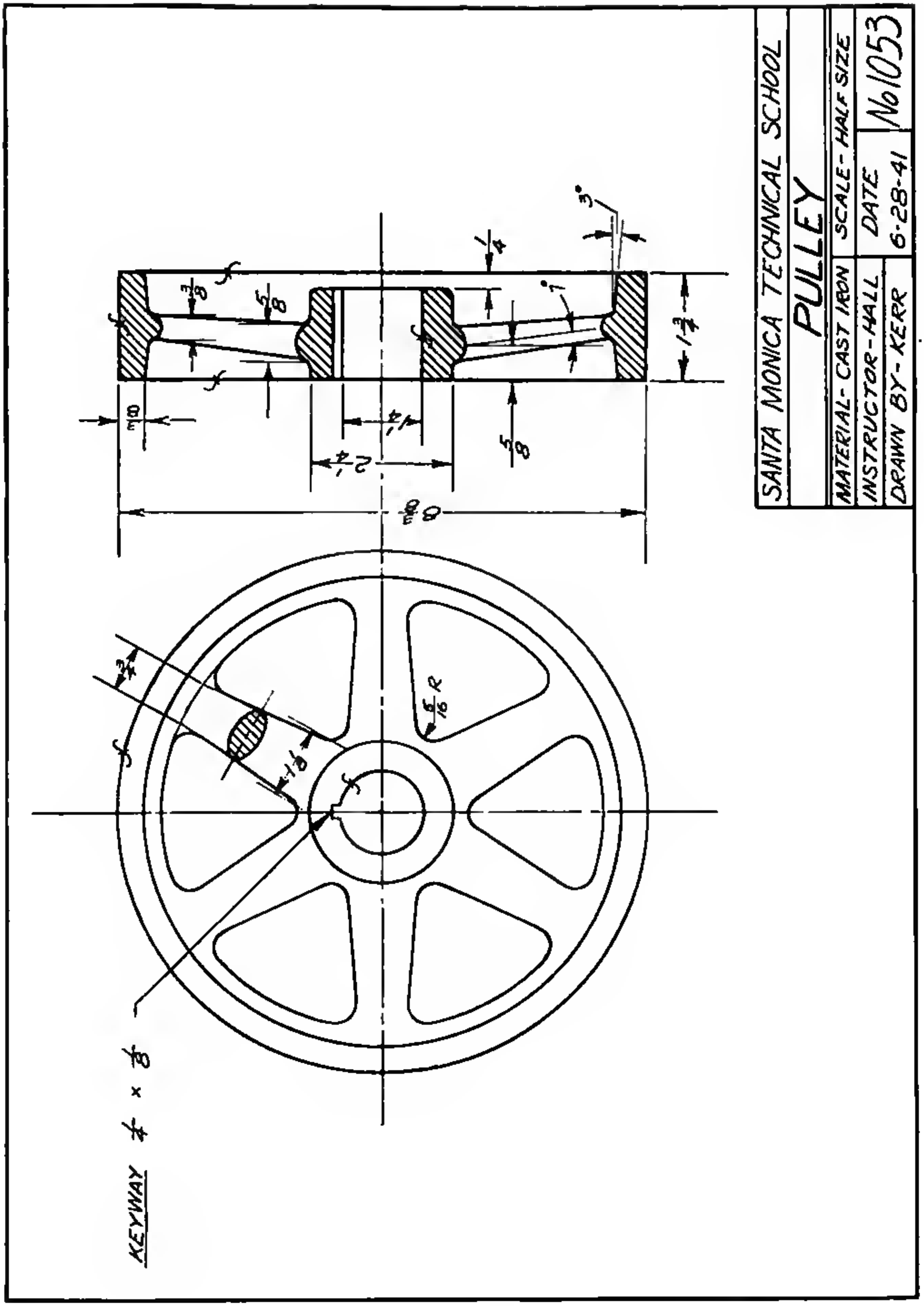


Fig. 210.

Fig. 211.


SANTA MONICA TECHNICAL SCHOOL
PULLEY
MATERIAL- CAST IRON
SCALE- HALF SIZE
INSTRUCTOR-HALL
DATE
6-28-41
DRAWN BY-KERR
No 1053
KEYWAY 1/4 × 1/8

70. HOW TO USE RAM-UP CORES

In medium or large-sized work there are cases where a part will extend out on the pattern as a knob or handle (Fig. 212). It may be inconvenient for the molder to have a core print here; therefore a core called a *ram-up core* is used in such instances. A core box is made with the part extending in the core (Fig. 213). A square is usually painted on the pattern the size of the core to locate it (Fig. 212).

The pattern is rammed up to this point. The core is then set against the pattern at the painted square. Molding sand is put around the core to hold it in place. Then the flask is filled with sand and the molding operation is carried on as usual. As the pattern is drawn out, the ram-up core is already in place. The metal will run into this cavity or the inside of the core and make the part wanted.

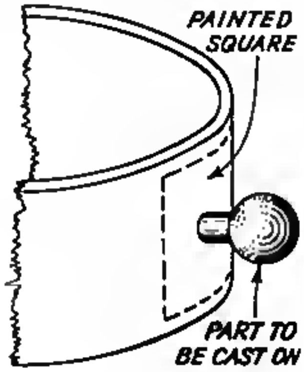


FIG. 212.

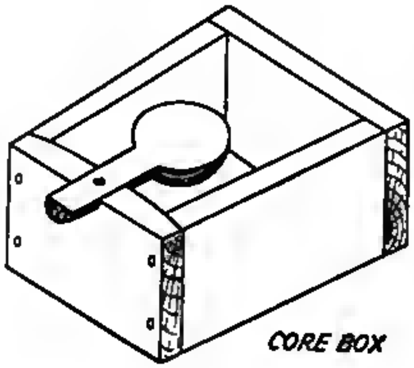


FIG. 213.

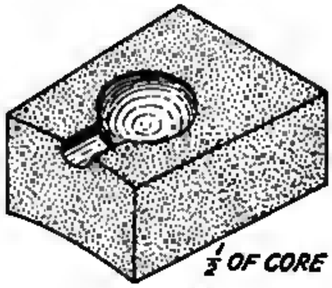
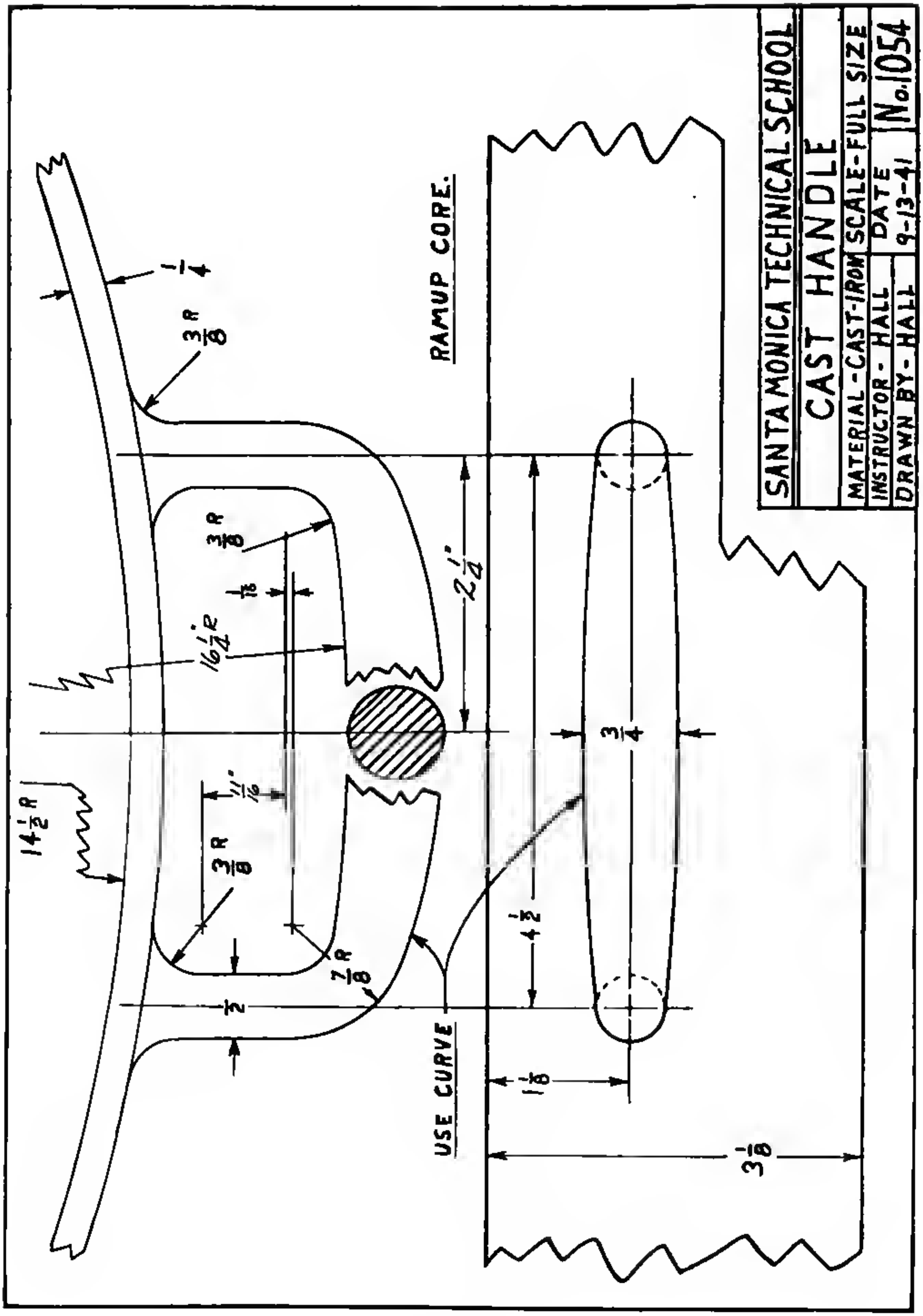


FIG. 214.


SANTA MONICA TECHNICAL SCHOOL
CAST HANDLE
MATERIAL - CAST-IRON
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 9-13-41
DRAWN BY - HALL
No. 1054
RAMUP CORE.
USE CURVE
1/4
3/8 R
2 1/4"
16 1/4 R
14 1/2 R
11/16"
1/16
7/8 R
1/2
4 1/2
3/4
1 1/8
3 1/8

71. HOW TO USE STOP-OFFS

Thin patterns will often warp, or the bottom board that the molder uses will be crooked and ruin the casting. A strip across the pattern will prevent these errors. This strip is called a *stop-off* and is usually placed cross grained on flat work with an 8- to 10-deg. draft.

The pattern is molded in the regular way except that after the molder has drawn the pattern out he then fills in the cavity in the mold so the casting will be smooth where the impressions of the stop-offs were.

These stop-offs are indicated on the pattern by shellacking black diagonal strips on a yellow base. The pattern should be shellacked yellow first and the strips later.

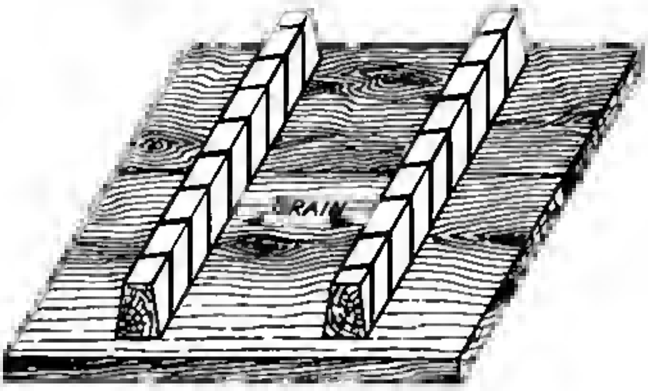


FIG. 215.

72. HOW TO USE OVERHANG ON COPE PRINTS

Overhang on cope prints is used mostly in medium and large pattern work. The reason for this is that the cope can be replaced without danger of being scraped or "shaved" by the protruding section of core resting in the drag (Fig. 217). This is a blind set for the molder. It would be almost impossible to replace the cope if the core prints on this side fitted perfectly.

Core prints that can have plenty of draft do not need overhang. When it is necessary, give the drag side just a little draft and three or more degrees on the cope side to make the overhang (Fig. 218). Do not cut this out in the core box, because the little wedge shape left in the cope by the overhang will do no harm as it will make only a small fin on the casting and can be ground off. If this overhang is on the end of the print, the metal cannot run around the core.

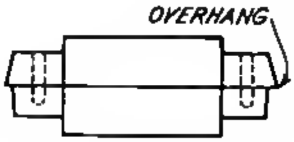


Fig. 216.

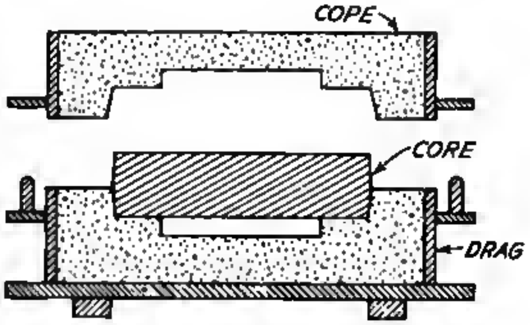


Fig. 217.

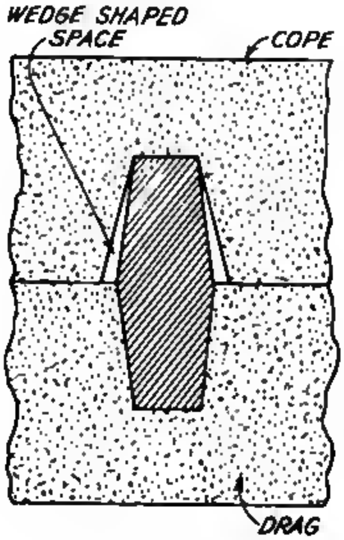


Fig. 218.

73. HOW TO MAKE STAVED OR LAGGED-UP PATTERNS

A pattern or core box of the cylindrical type should be staved or, as it is sometimes called, *lagged up*. The reasons for this are that it makes the pattern lighter to handle; it will not shrink, as there is less material; and it will hold its shape better. It is also stronger and will last longer.

Staves are run across to the heads or ends of the job. Starting at the center or parting line and working to the center or top of each half, each stave is glued and nailed. A brace should be run through each head at the parting line or center of the pattern (Fig. 219). In medium-sized work, the undersides of the staves can be cut on the table saw by running them through with a straight edge clamped at an angle as in Fig. 223, and the bevels on the edges can be used direct from the saw without further planing. These staves should be about 1 in. thick, with the width depending upon the radius of the head. If a large radius is used, the heads are cut flat under the staves. The circumference is spaced in even parts and the staves cut to fit (Fig. 221). Stock on the outside of the pattern should be turned or trimmed off. The core-box stock (Fig. 220) should be left on the inside for finishing.

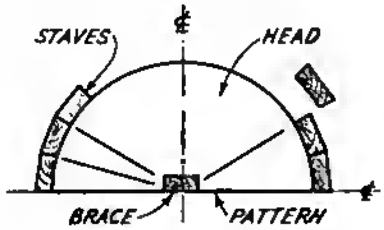


Fig. 219.

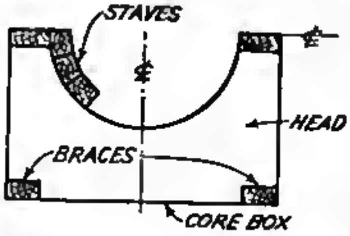


Fig. 220.

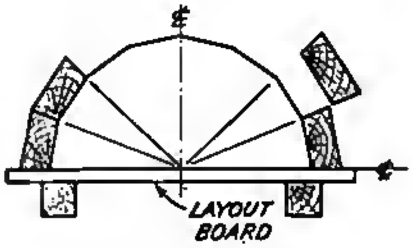


Fig. 221.

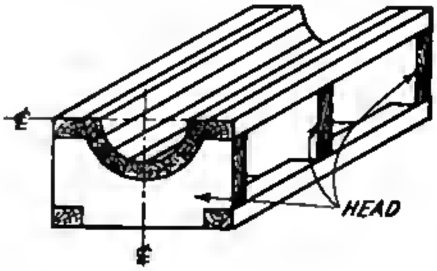
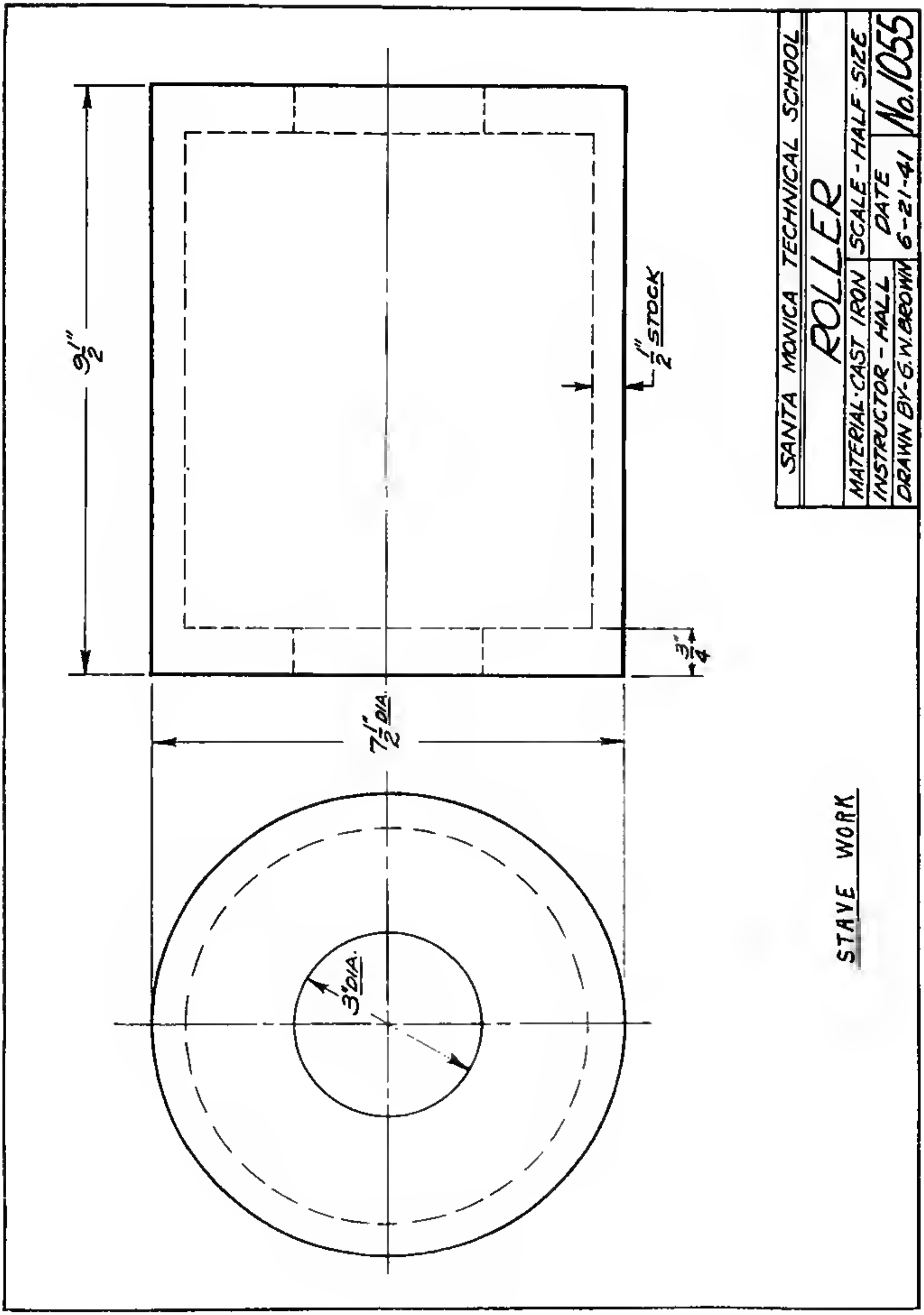


Fig. 222.


SANTA MONICA TECHNICAL SCHOOL
ROLLER
MATERIAL-CAST IRON
SCALE - HALF SIZE
INSTRUCTOR - HALL
DATE
DRAWN BY-G.W.BROWN
6-21-41
No. 1055
STAVE WORK
9 1/2"
1/2" STOCK
3/4"
7 1/2" DIA.
3" DIA.

74. HOW TO CUT CONCAVE STAVES ON THE TABLE SAW

Probably the simplest and quickest method of concaving staves for lagged-up patterns or core boxes is to run them over the table saw. With the saw extending through the table the distance of the stock to be cut out at *A*, reverse one of the staves and clamp it on the saw table at an angle as shown in Fig. 223. This angle can be determined by squaring off the stave at the two points on the width the saw will cut at *B*. If the radius wanted on the stave is larger than the radius of the saw, two or three cuts may be necessary on each stave to cut to the radius line. Always check the first stave you run on the job to be sure of a good fit. It may be necessary to shift the stave that is clamped to the saw table a little, one way or the other, to get a satisfactory joint.

Always make two or three extra staves while the saw is set up. You may ruin or find checks on some. Be sure the first stave is right. Then proceed with the rest.

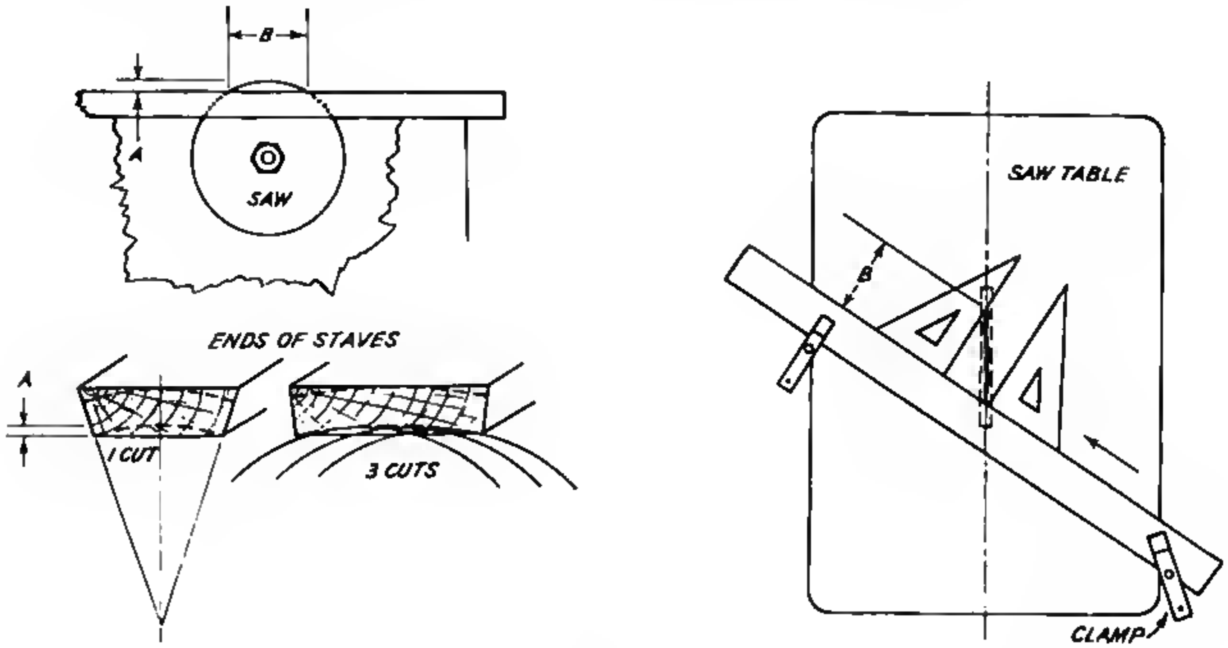


Fig. 223.

75. HOW TO USE BLOCKS, FRAMES, OR FOLLOW BOARDS

Thin-shell or frail patterns are very easily sprung out of shape and possibly broken while being rammed up in the mold by the molder. Many times a support can be made to protect the pattern from springing or breaking. If the pattern is of uniform shape or fairly straight on the cope side, a block called a *ram-up block* is made to fit under the thin-shelled pattern. If this is made to fit perfectly, it is almost impossible to spring or break the pattern by ramming.

If the pattern is irregular or crooked, a composition called *Tamastone* or a casting plaster is used to make a match frame or follow board. This is made by ramming up the drag side of the pattern, just hard enough to hold in place, making sure the parting line is correct, then smoothing the face of the mold and greasing the pattern with cup grease. A wood frame is made at least 2 in. above the highest point on the pattern. Strips of wood are nailed around on the inside of the frame, or nails may be driven halfway in to anchor the composition into the frame. The top of the frame is covered with a board having a hole large enough through which to pour the composition. This frame is placed on top of the drag and weighted or clamped down. The mixture is poured in the top hole and let set for 30 min. It is then rolled over carefully and lifted off the drag to remove sand and the pattern. When the face is cleaned off, it is ready for use.

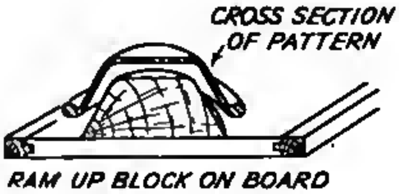


FIG. 224.

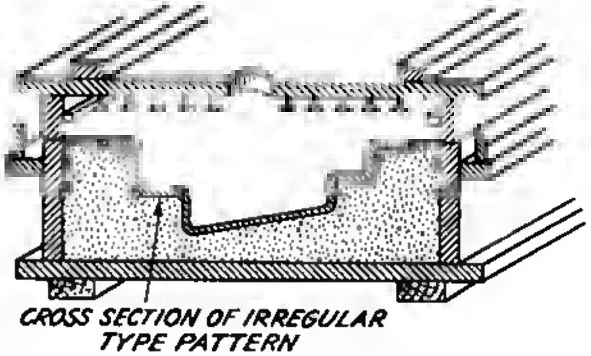


FIG. 225.

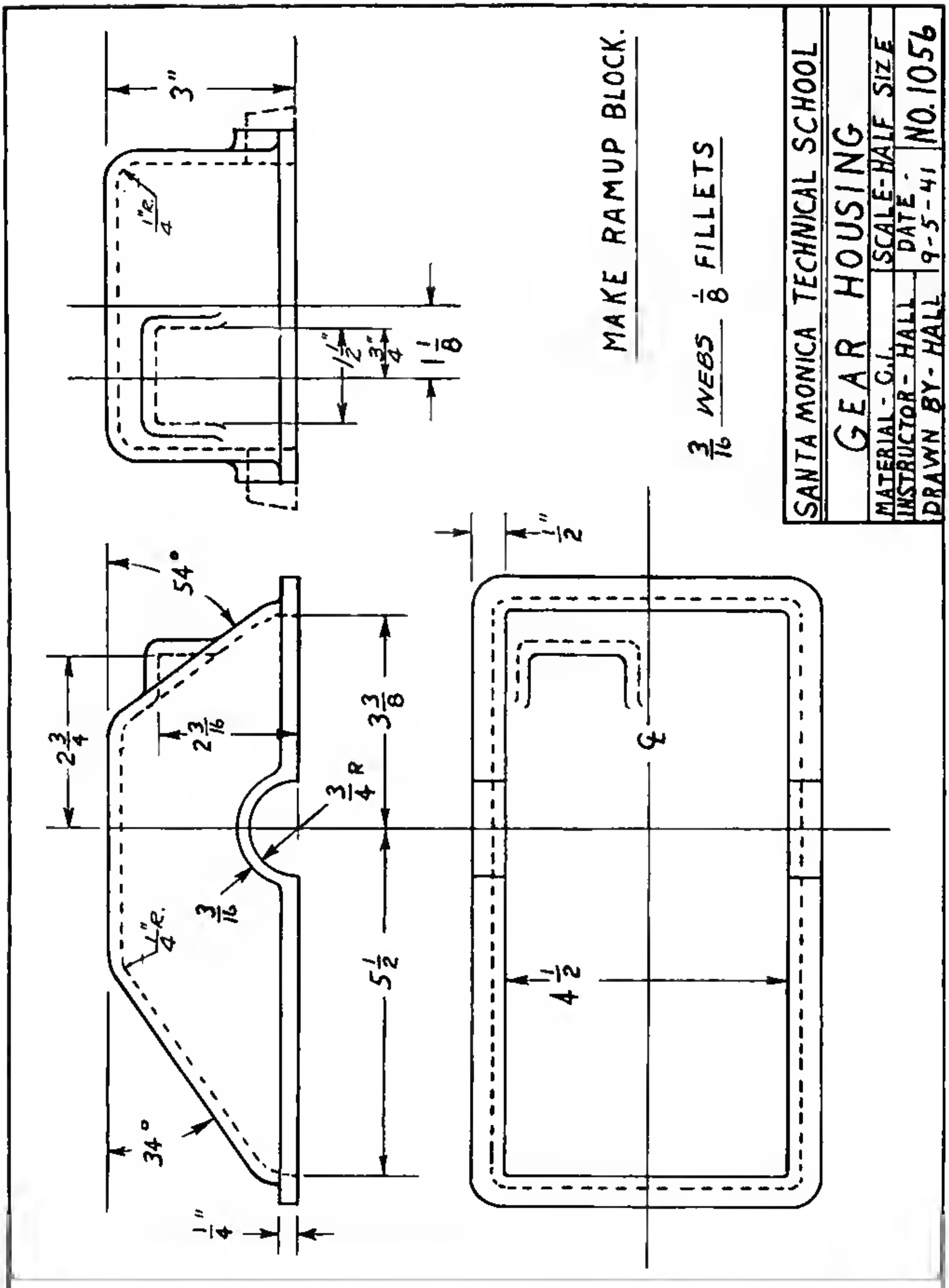
76. HOW TO MAKE A RAM-UP BLOCK FOR PATTERN ON BLUEPRINT 1056

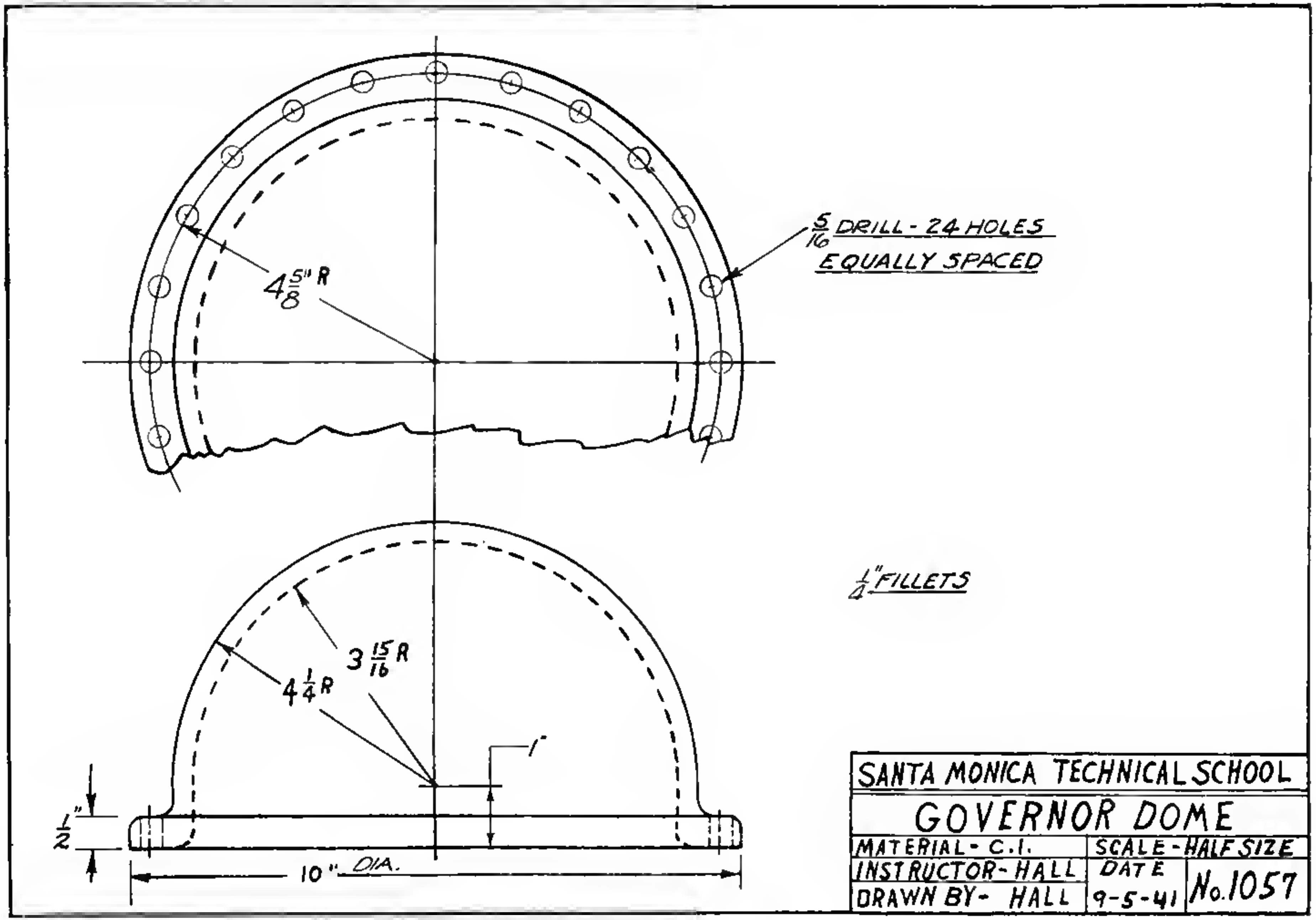
In making the pattern for the gear housing, a ram-up block should be made first.

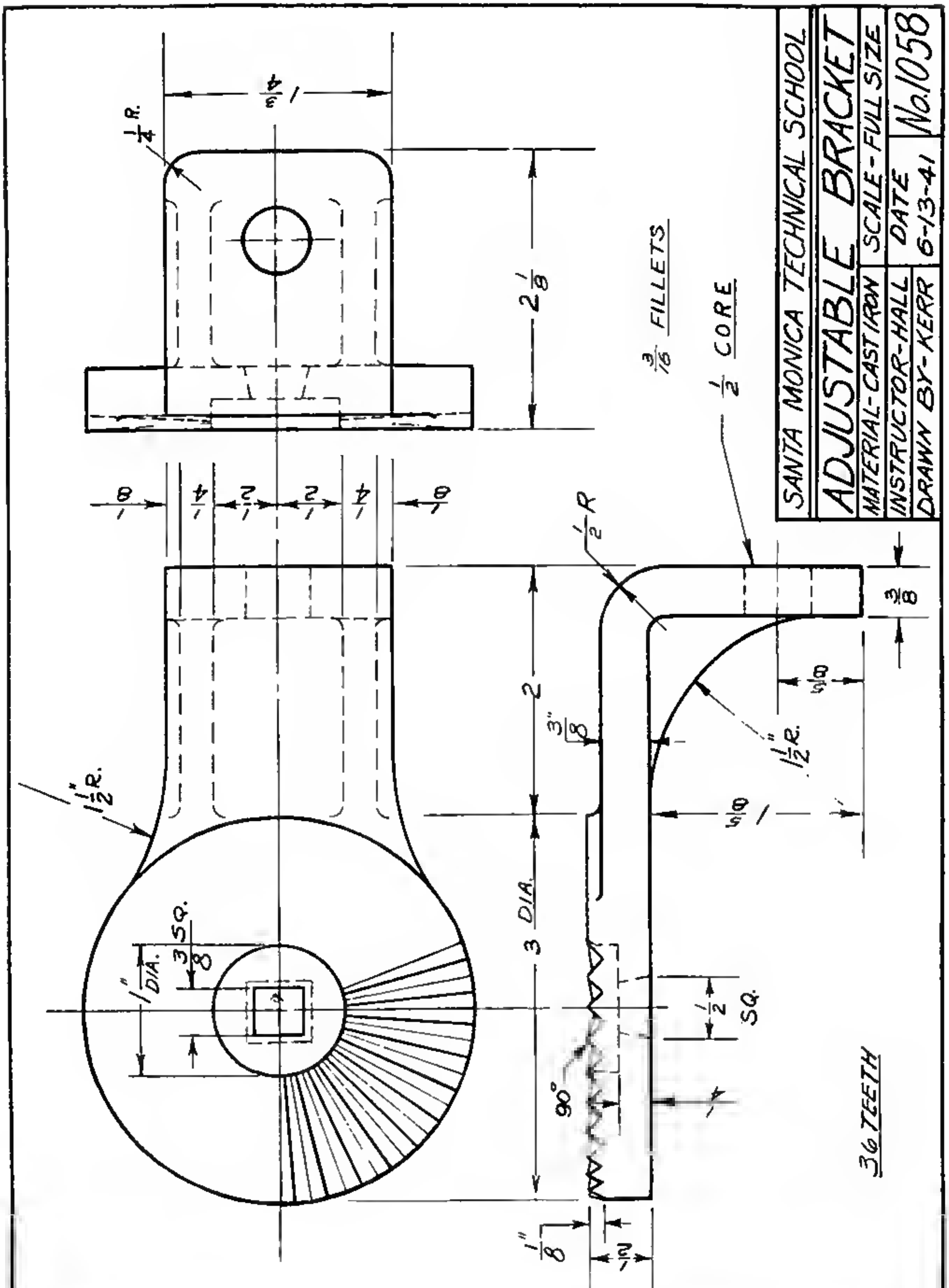
A block $2\frac{13}{16}$ in. thick and $4\frac{1}{2}$ in. wide and approximately 10 in. long should be built up. Lay out the block to *inside* dimensions of the pattern; saw and sand to this line. This block should be sanded with 1 deg. draft on the sides and ends.

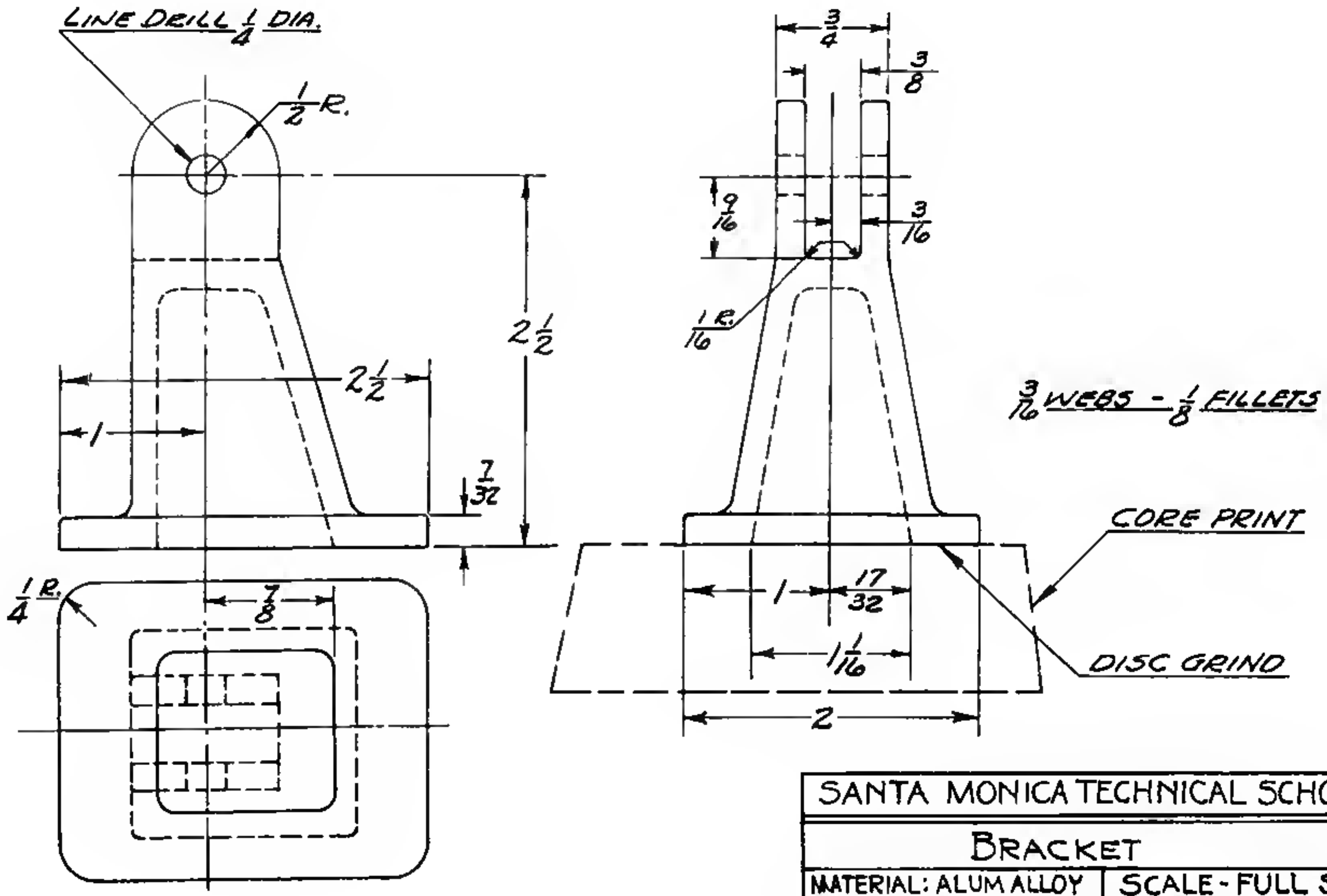
Next get out the two pieces with $\frac{3}{4}$-in. radius that fit the bearing cutouts. Glue and nail them in the proper places. These half-round projections should be $\frac{1}{4}$ to $\frac{1}{2}$ in. longer than the pattern, with 4 or 5 deg. draft on the ends as shown on the print. This will make it easier for the molder.

Locate and add the additional block on the top at the right end. This is to be built over, like the rest of the pattern, with $\frac{3}{16}$-in. stock. Now build the sides of the pattern on the block and add the top and flange around the base and also over the bearing cutouts. Glue in fillets, round corners, trim up, and sand.

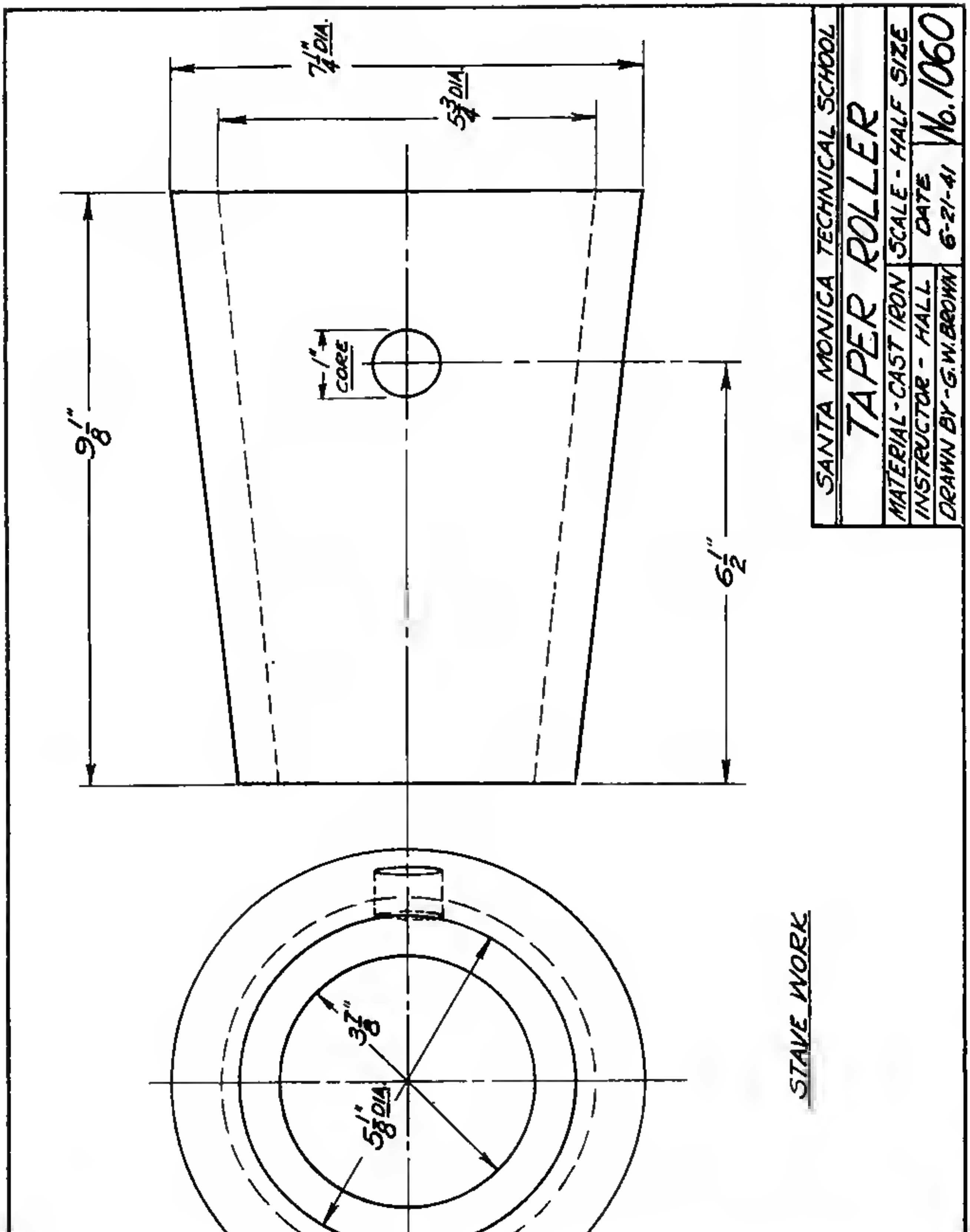

SANTA MONICA TECHNICAL SCHOOL
GEAR HOUSING
MATERIAL - C.I.
SCALE - HALF SIZE
INSTRUCTOR - HALL
DATE - 9-5-41
DRAWN BY - HALL
NO. 1056
MAKE RAMUP BLOCK.
3/16 WEBS 1/8 FILLETS
3"
1/4" R.
1/2"
3/4"
1 1/8
1/2"
54°
2 3/4
2 3/16
3 3/8
3/4 R
3/16
1/4" R.
5 1/2
4 1/2
34°
1/4"
℄


$\frac{5}{16}$ DRILL - 24 HOLES
EQUALLY SPACED
$4\frac{5}{8}$" R
$\frac{1}{4}$" FILLETS
$3\frac{15}{16}$ R
$4\frac{1}{4}$ R
1"
$\frac{1}{2}$"
10" DIA.
SANTA MONICA TECHNICAL SCHOOL
GOVERNOR DOME
MATERIAL - C.I.
SCALE - HALF SIZE
INSTRUCTOR - HALL
DATE
9-5-41
DRAWN BY - HALL
No. 1057

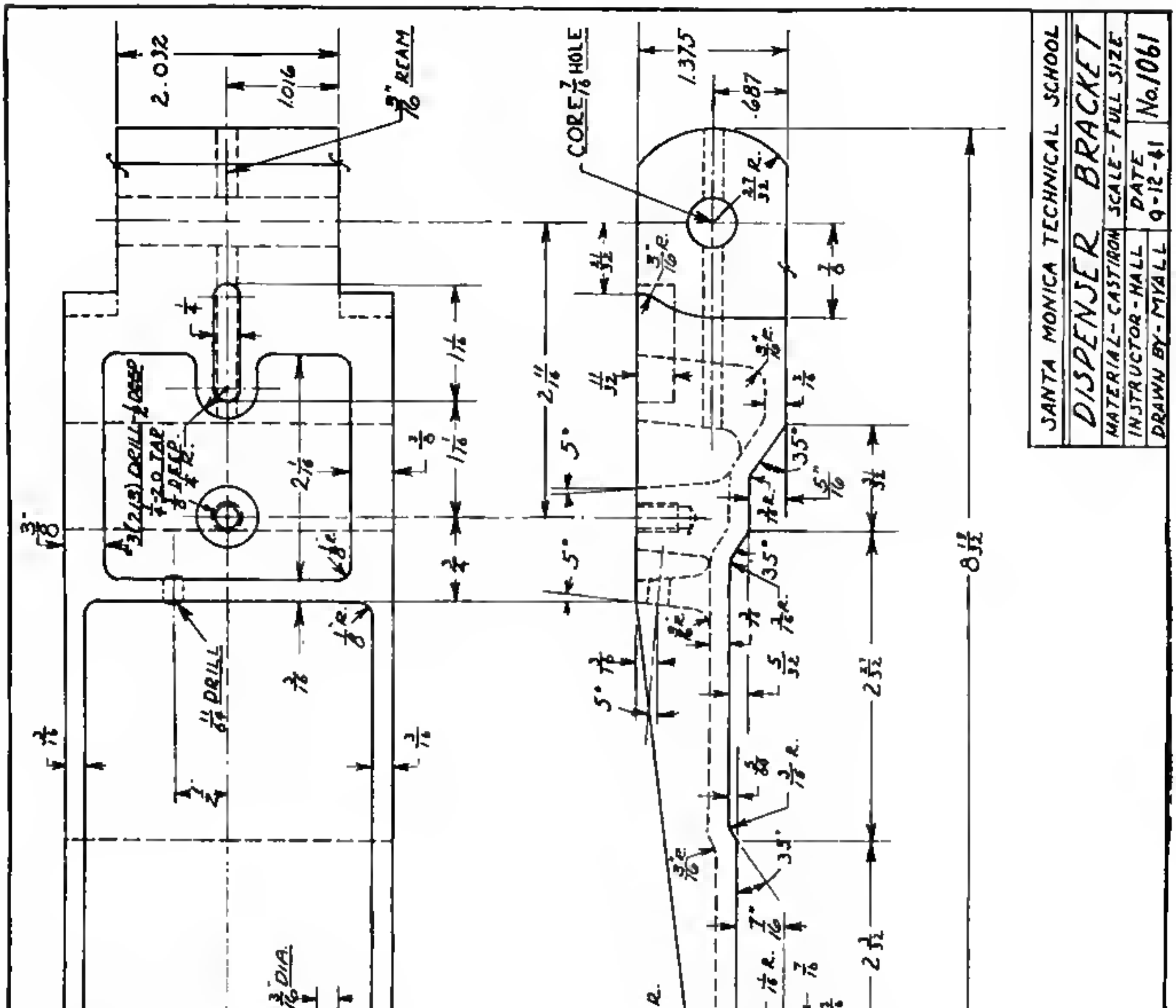

SANTA MONICA TECHNICAL SCHOOL
ADJUSTABLE BRACKET
MATERIAL-CAST IRON
SCALE-FULL SIZE
INSTRUCTOR-HALL
DATE 6-13-41
DRAWN BY-KERR
No.1058
3/16 FILLETS
1/2 CORE
36 TEETH
3 DIA.
1" DIA.
3/8 SQ.
1/2 SQ.
90°
1 1/2" R.
1/2 R
1/4 R.

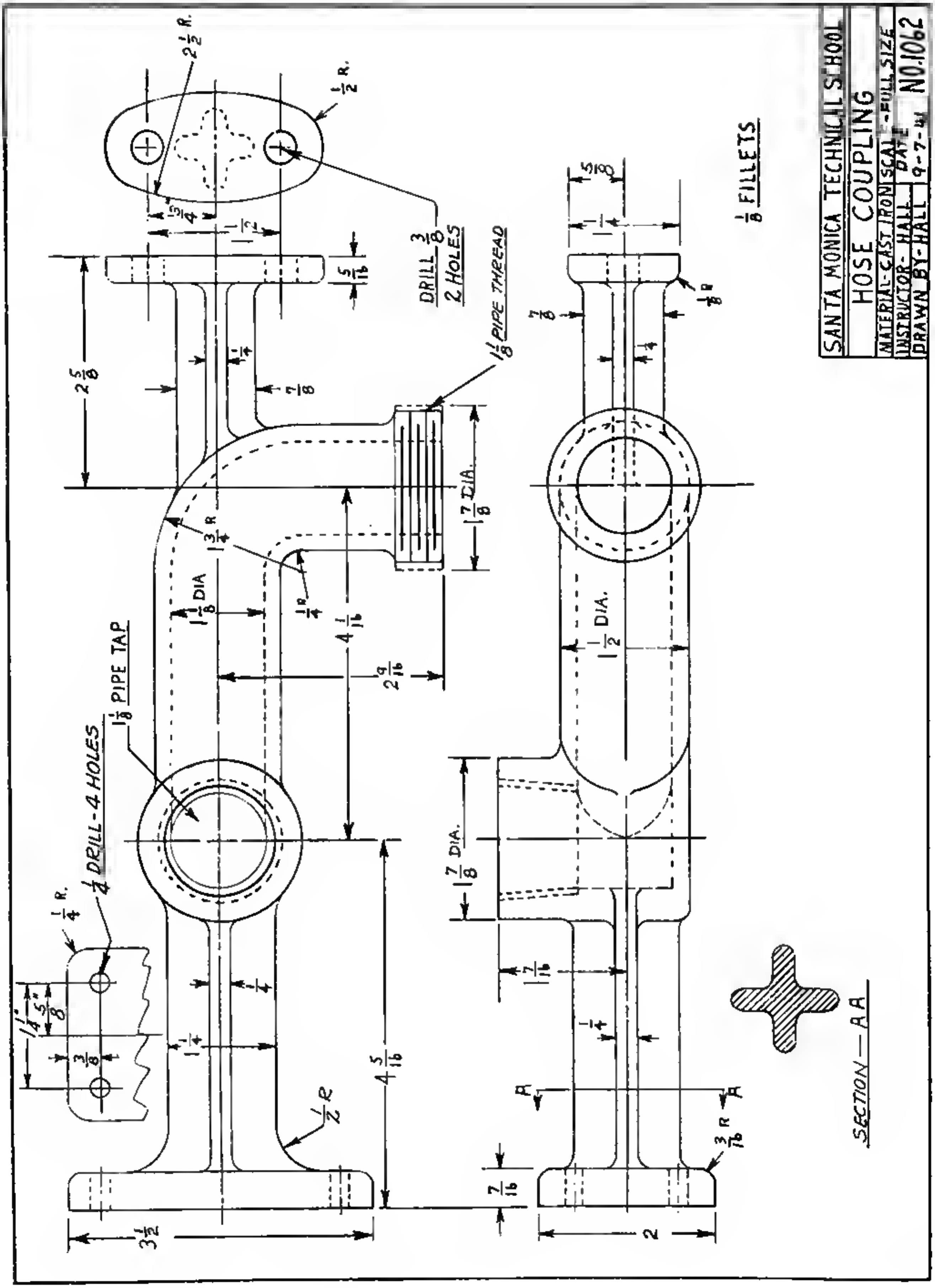


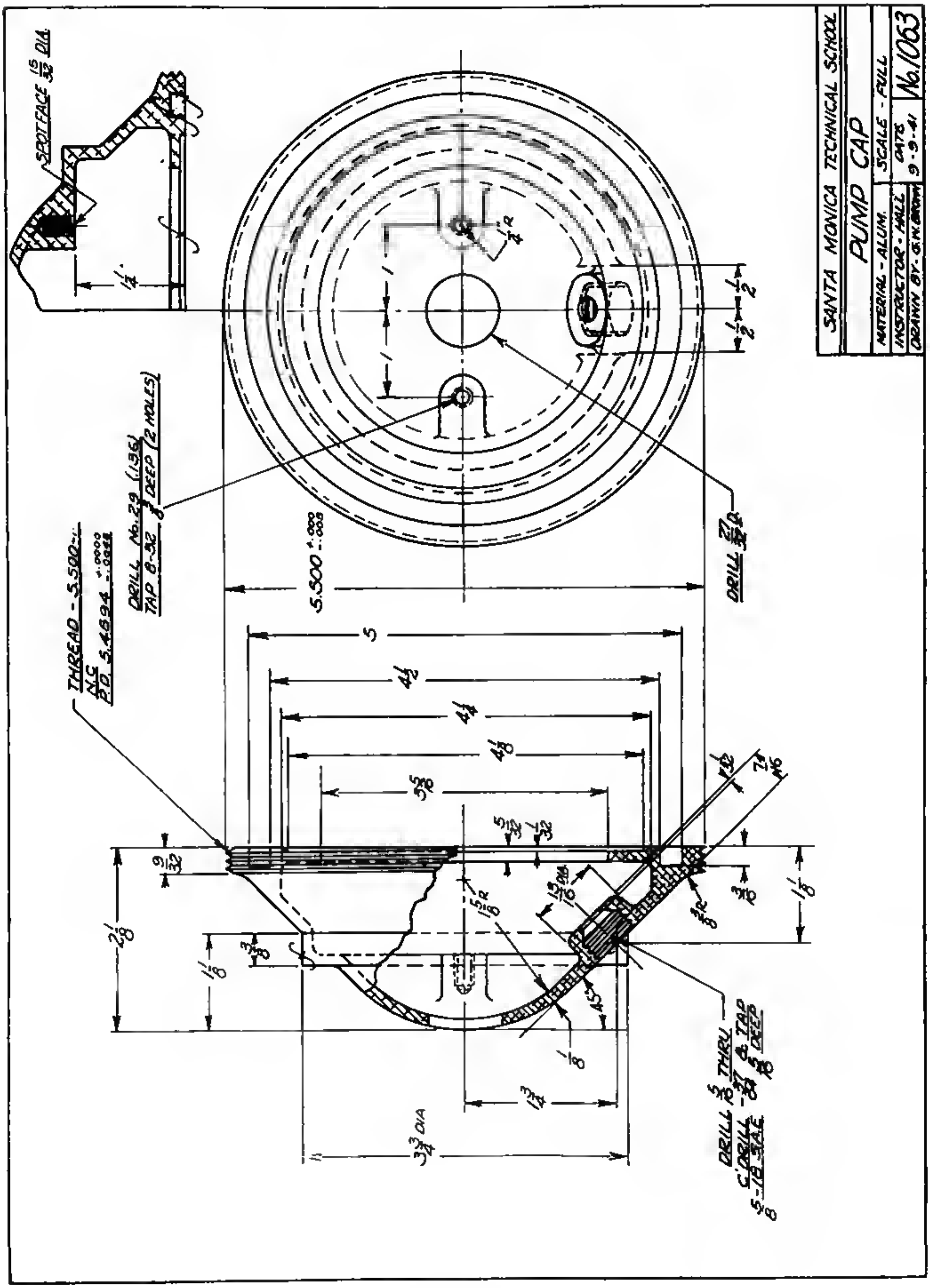
SANTA MONICA TECHNICAL SCHOOL		
BRACKET		
MATERIAL: ALUM ALLOY	SCALE - FULL SIZE	
INSTRUCTOR - HALL	DATE	№ 1059
DRAWN BY - GOEN	1-7-42	

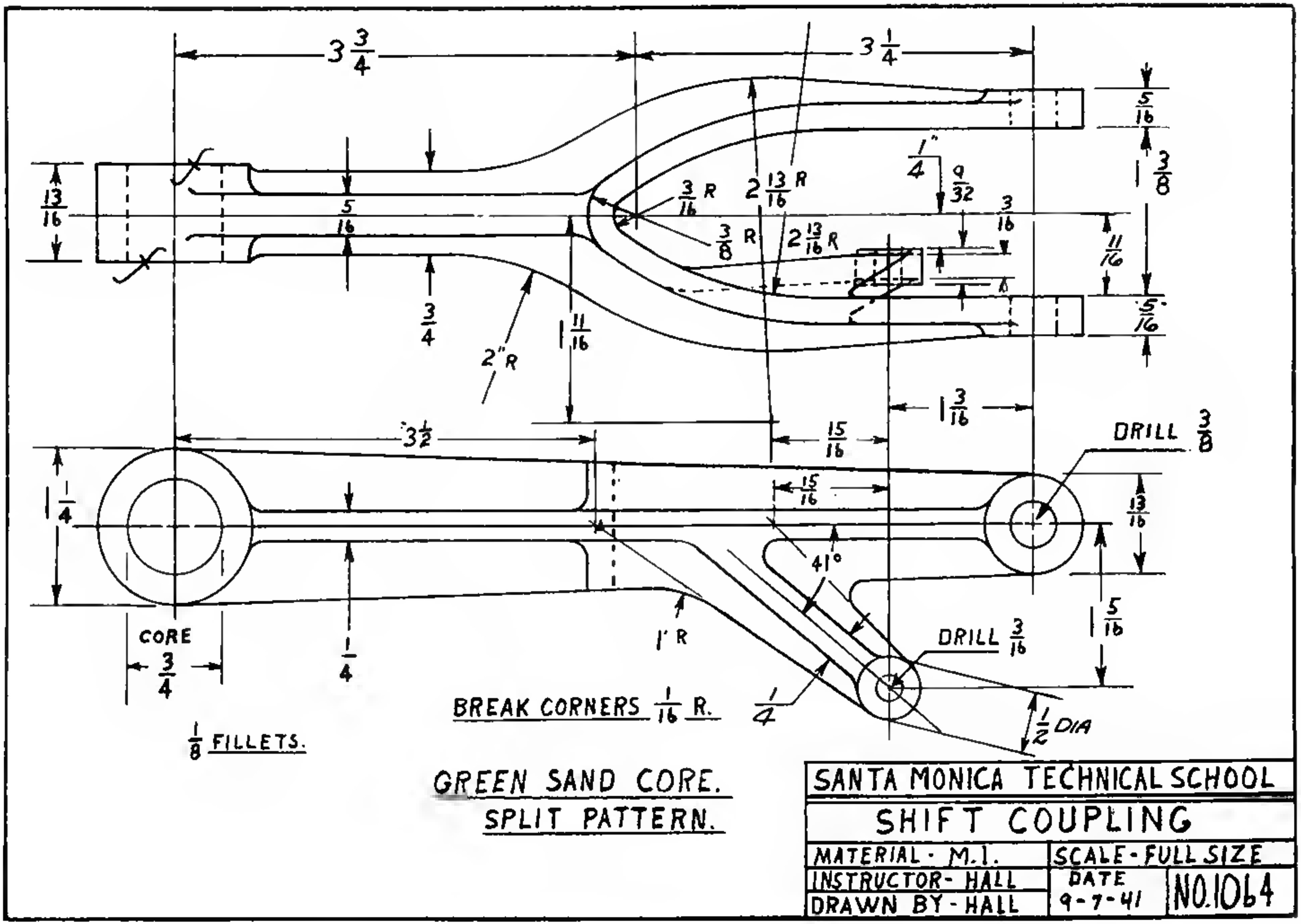


SANTA MONICA TECHNICAL SCHOOL
TAPER ROLLER
MATERIAL - CAST IRON
SCALE - HALF SIZE
INSTRUCTOR - HALL
DATE 6-21-41
DRAWN BY - G.W.BROWN
No. 1060
7 1/4" DIA.
5 3/4 DIA.
9 1/8"
1" CORE
6 1/2"
3 7/8"
5 1/8" DIA.
STAVE WORK


SANTA MONICA TECHNICAL SCHOOL
DISPENSER BRACKET
MATERIAL-CASTIRON
SCALE-FULL SIZE
INSTRUCTOR-HALL
DATE 9-12-41
DRAWN BY-MYALL
No.1061
CORE 7/16 HOLE
5° TAPER SIDES
1/8" DRILL-2 HOLES C'SK. 90°x 1/4 DIA.
11/64 DRILL
3/16" REAM


SANTA MONICA TECHNICAL SCHOOL
HOSE COUPLING
MATERIAL-CAST IRON
SCALE-FULL SIZE
INSTRUCTOR-HALL
DATE 9-7-41
DRAWN BY-HALL
NO.1062
1/8 FILLETS
DRILL 3/8
2 HOLES
1 1/8 PIPE THREAD
1 1/8 PIPE TAP
1/4 DRILL-4 HOLES
SECTION—AA


SANTA MONICA TECHNICAL SCHOOL
PUMP CAP
MATERIAL - ALUM.
SCALE - FULL
INSTRUCTOR - HALL
DATE 9-9-41
DRAWN BY - G.H. BROWN
No. 1063
SPOTFACE 15/32 DIA.
THREAD - 5.500 - N.C.
P.D. 5.4894 +.0000 -.0048
DRILL No. 29 (.136)
TAP 8-32 3/8 DEEP (2 HOLES)
5.500 +.000 -.003
DRILL 27/32 D.
DRILL 5/16 THRU
C'DRILL - 37/64 & TAP
5/8 - 18 SAE 5/16 DEEP
3 3/4 DIA
45°


3 3/4
3 1/4
5/16
1 3/8
5/16
13/16
5/16
3/4
1"/4
9/32
3/16
11/16
3/16 R
2 13/16 R
3/8 R
2 13/16 R
2" R
1 11/16
1 3/16
15/16
15/16
3 1/2
1 1/4
41°
DRILL 3/8
13/16
1 5/16
DRILL 3/16
1/2 DIA
1/4
1" R
1/4
CORE 3/4
BREAK CORNERS 1/16 R.
1/8 FILLETS.
GREEN SAND CORE.
SPLIT PATTERN.
SANTA MONICA TECHNICAL SCHOOL
SHIFT COUPLING
MATERIAL - M.I.
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 9-7-41
NO. 1064
DRAWN BY - HALL

77. DEFINITIONS AND ABBREVIATIONS OF GEAR MARKINGS

When two gears are engaged, they are in mesh (Fig. 226).

The pitch diameter of a gear is the line on the tooth that travels the same speed as the one in mesh regardless of size, like two rollers coming together (Fig. 227).

The pitch diameter is marked on blueprints as P.D.

The outside diameter is marked on blueprints as O.D.

The root diameter of a gear is marked on blueprints as R.D.

The circular pitch is a distance measured on the circle from the center of one tooth to the center of another (Fig. 226).

To get the circular pitch of a gear, multiply the pitch diameter by 3.1416 and divide by the number of teeth in the gear. *Example:* If the pitch diameter of a gear is 3.500 and the gear has 21 teeth, multiply 3.500 by 3.1416, which would be 10.9956. Then divide by 21, which would give 0.5236, or just under $^{17}/_{32}$, as the circular pitch.

The diametrical pitch is the number of teeth per inch of pitch diameter. To obtain this, divide the number of teeth by the pitch diameter. *Examples:* Gear with 21 teeth, pitch diameter 3.500: $\frac{21}{3\frac{1}{2}} = 6$, or a six-pitch gear. Gear with 48 teeth, pitch diameter 12 in.: $^{48}/_{12} = 4$, or a four-pitch gear.

The blueprint will show if it is a 4-, 6-, 8-, 10-, 16-pitch gear, although it makes very little difference to the patternmaker, as most prints have all the necessary measurements on them before they leave the drafting room.

The pressure angle line on a tooth is the angle at which the tooth pressure is applied and distributed, and this is the line at which the tooth radius is taken. The tooth radius figure is given on the blueprint.

When one gear is smaller than the other and they work together, the smaller one is called a *pinion* (Fig. 227).

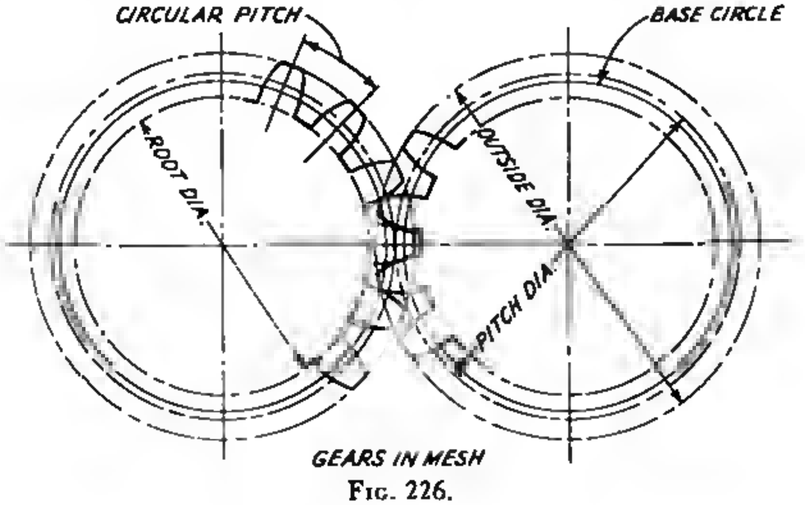


Fig. 226.

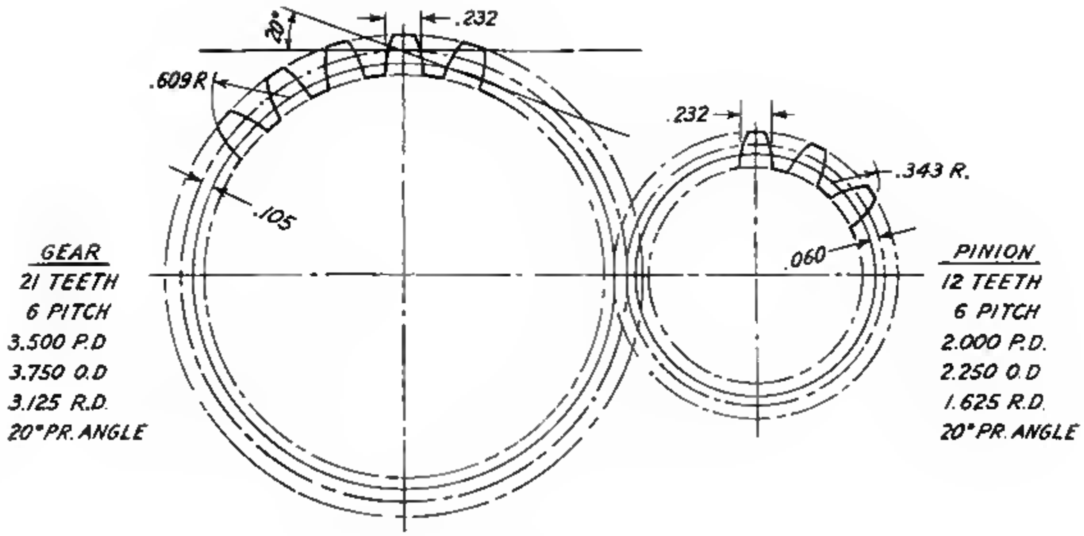


Fig. 227.

78. HOW TO MAKE SMALL SPUR-GEAR PATTERNS

End wood is the best for use on small gear patterns when the teeth are cut from the blank turning, unless the web of the pattern is exceptionally thin. Straight grain should be selected for all cutout gear pattern work.

1. Turn out gear blank (Fig. 228). If the pattern is turned on both sides, do the heavy turning first; then take it off, rechuck, and finish turning.

2. Mark in with dividers the pitch diameter, root diameter, tooth radius diameter. Space the teeth and mark in tooth center lines with surface gage before taking the pattern out of the lathe (Fig. 228).

3. Lay out the width of the tooth on pitch diameter and mark in the tooth radius. If it is a narrow-faced gear, 1 in. or less, a one-side layout is sufficient.

4. Band saw fairly close to the line, and trim to the line with a chisel. Use a block sanded with draft to get a straight face on each tooth. Lay both gear and block flat on the bench or layout board, and use crayon on the block to find the high places (Fig. 228).

5. Use sandpaper on a thin piece of wood while sanding or the teeth will become rounded or crowned. This requires great care, as one may ruin the pattern on the last operation.

One-half degree is sufficient draft for any spur-gear pattern.

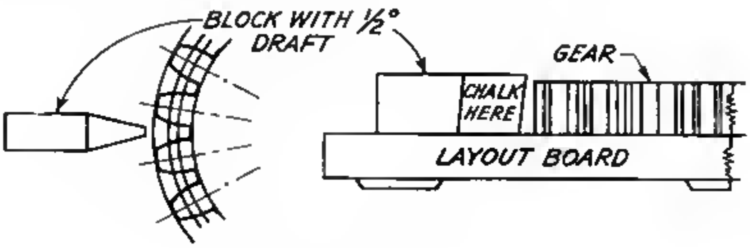
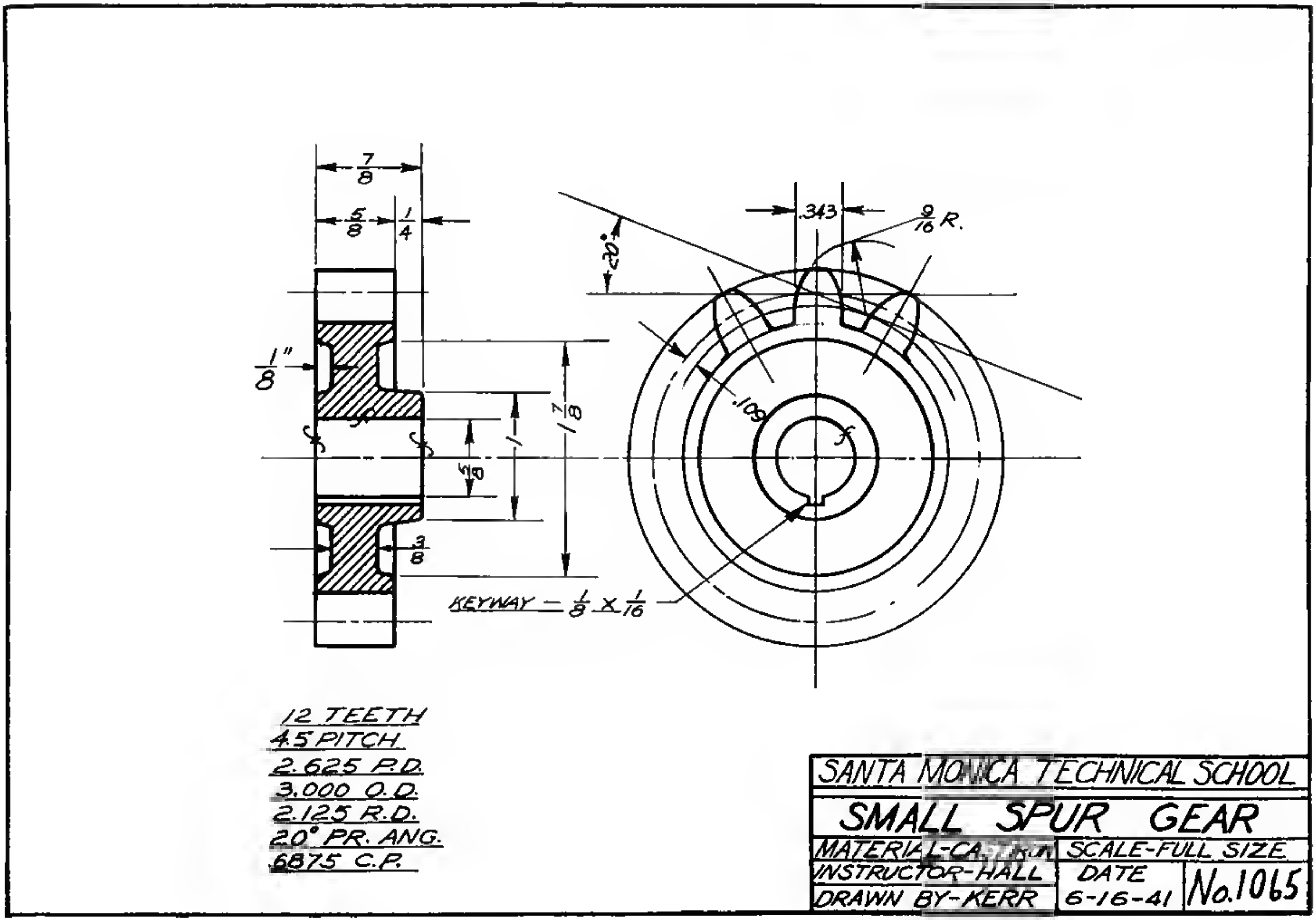


Fig. 228.



7/8
5/8
1/4
1/8"
3/8
5/8
1
1 7/8
KEYWAY — 1/8 X 1/16
.343
9/16 R.
20°
.109
12 TEETH
4.5 PITCH
2.625 P.D.
3.000 O.D.
2.125 R.D.
20° PR. ANG.
.6875 C.P.
SANTA MONICA TECHNICAL SCHOOL
SMALL SPUR GEAR
MATERIAL-CAST IRON
SCALE-FULL SIZE
INSTRUCTOR-HALL
DATE
6-16-41
No.1065
DRAWN BY-KERR

79. HOW TO MAKE SMALL BEVEL-GEAR PATTERNS

Bevel-gear patterns are much the same as spur-gear patterns: There are outside diameter, pitch diameter, root diameter, etc. The difference is that the diameters are smaller on the inside of the tooth than on the outside, as all lines run to the center.

The patternmaker will have to make a layout of his own to get the lines needed. After this is made, he should proceed as follows: Turn the blank gear (Fig. 229) and lay out, marking in all radii outside and inside before taking it from the lathe. Then space the teeth and mark in tooth center lines with surface gage. Lay out teeth on both ends and cut through from inside.

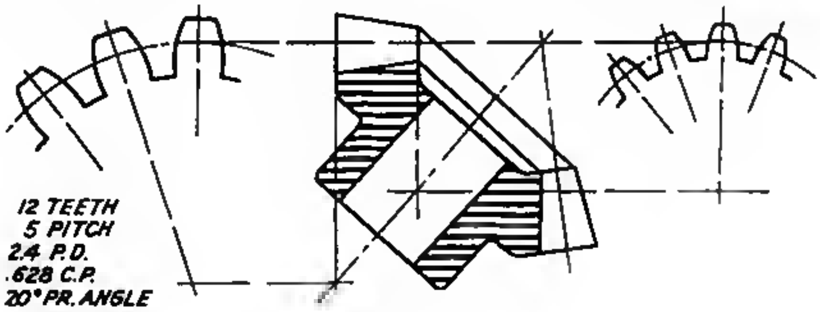
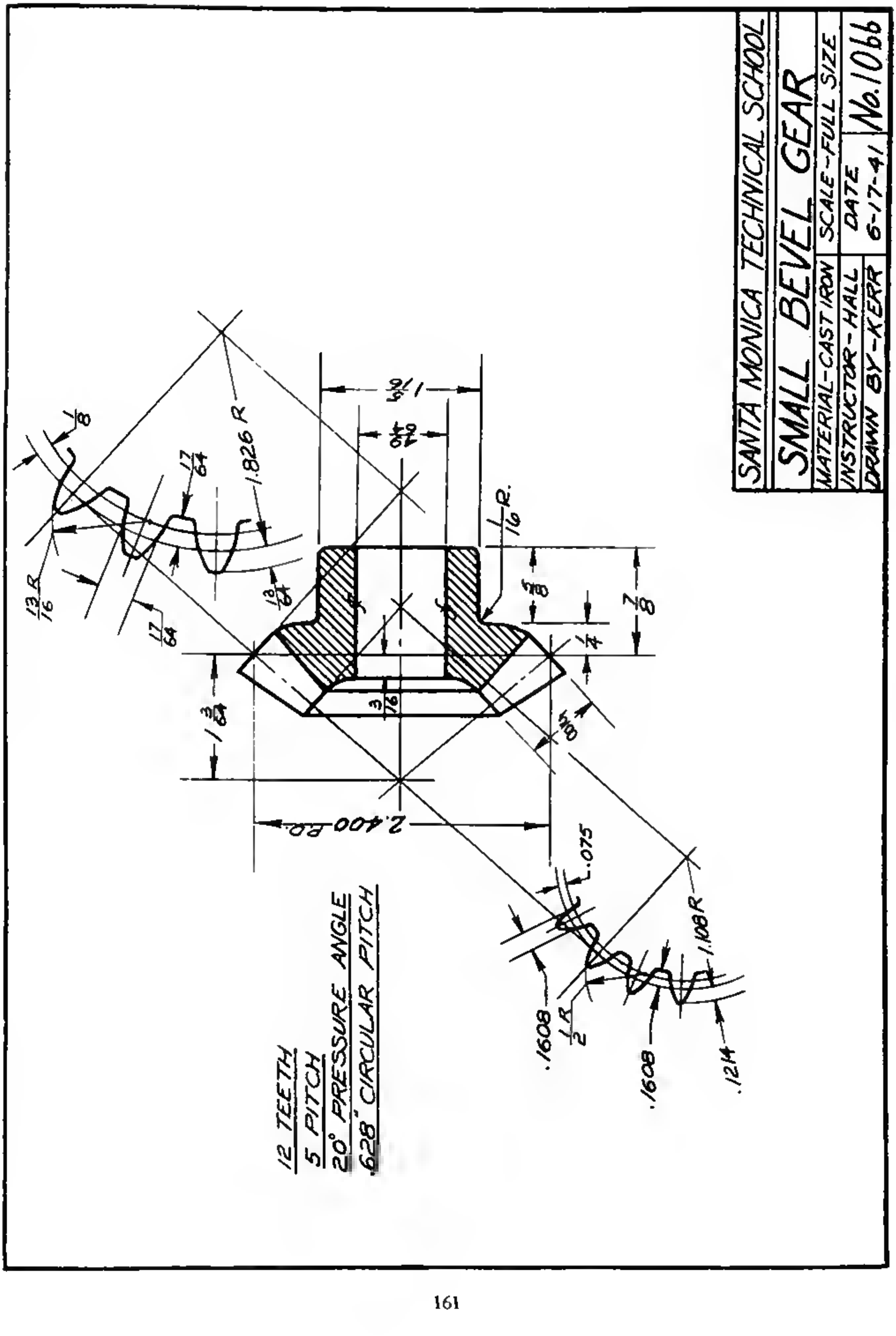
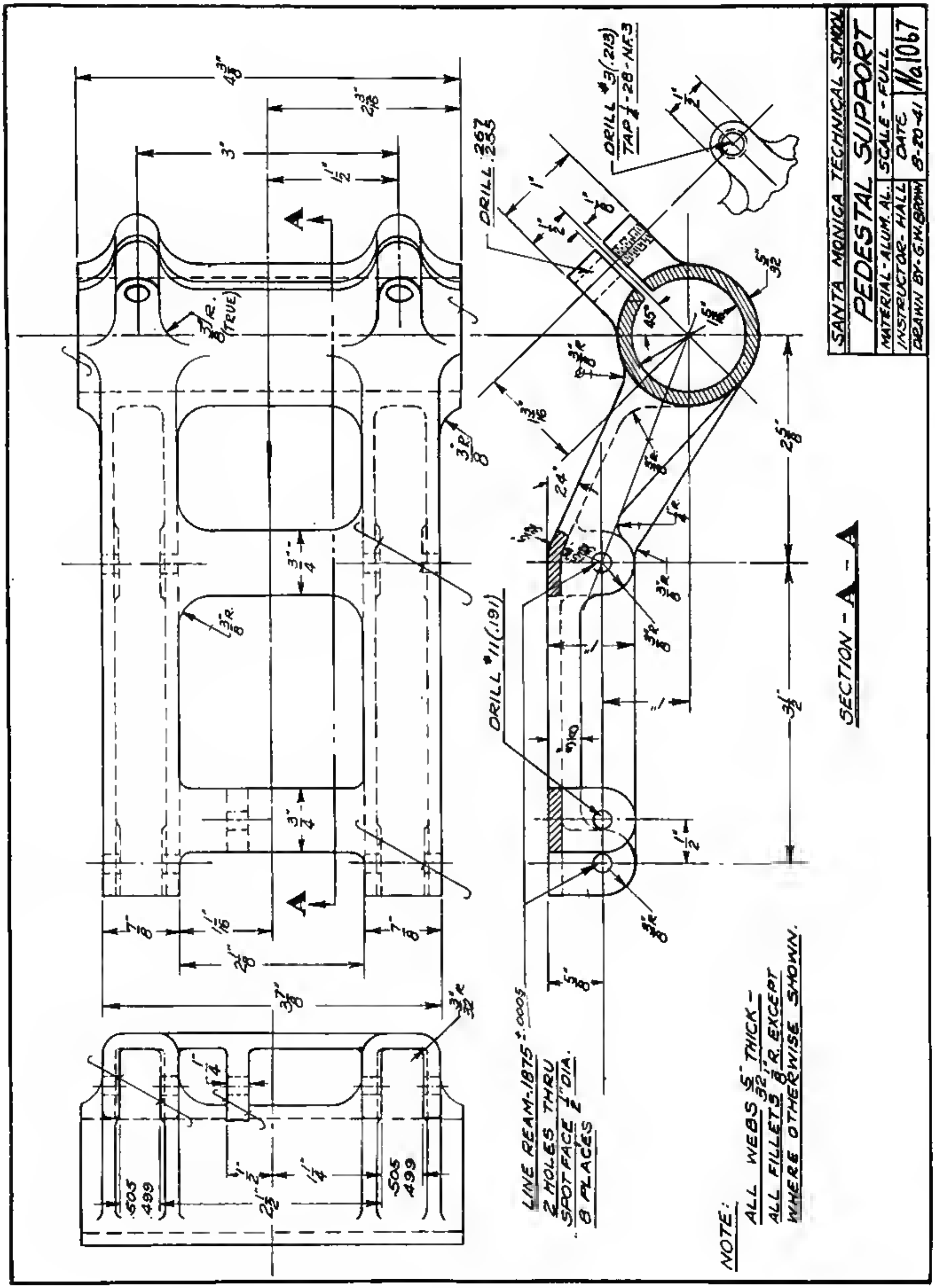


Fig. 229.


SANTA MONICA TECHNICAL SCHOOL
SMALL BEVEL GEAR
MATERIAL-CAST IRON
SCALE-FULL SIZE
INSTRUCTOR-HALL
DATE 6-17-41
DRAWN BY-KERR
No.10bb
12 TEETH
5 PITCH
20° PRESSURE ANGLE
.628" CIRCULAR PITCH
2.400 P.D.
1.826 R
1.108 R
.075
.1608
.1608
.1214
1/2 R
13/16 R
1/16 R.
17/64
17/64
13/64
1/8
1 3/64
7/8
5/8
1/4
3/16
1 7/16



SANTA MONICA TECHNICAL SCHOOL
PEDESTAL SUPPORT
MATERIAL-ALUM. AL.
SCALE - FULL
INSTRUCTOR - HALL
DATE 8-20-41
DRAWN BY - G.W. BROWN
No 1067
SECTION - A - A
DRILL #3 (.213)
TAP 1/4 - 28 - NF3
DRILL .267 .255
DRILL #11 (.191)
LINE REAM - .1875 ±.0005
2 HOLES THRU
SPOTFACE 1/2" DIA.
8 PLACES
NOTE:
ALL WEBS 5/32" THICK -
ALL FILLETS 1/8" R. EXCEPT
WHERE OTHERWISE SHOWN.

80. HOW TO MAKE MEDIUM OR LARGE SPUR-GEAR PATTERNS

1. If a gear pattern is too large to be cut out of a solid piece, the rim, or possibly the whole pattern, should be made up of segments. This pattern should be laid up like any other pattern of the same type and turned to the root diameter, taken from the layout. The teeth should next be finished and added on.

2. The teeth can be made exactly alike by using a jig that will give each tooth the proper draft. For teeth of medium size, use a piece of hardwood stock 2 or 3 in. longer than the length of the tooth and 1/4 to 1/2 in. wider. Draw a center line on both ends and edges.

3. Lay out the O.D., P.D., R.D., and the tooth radius diameter on each end; then draw in the shape of the tooth on each end. Allow 1/2-deg. draft or not more than 1/32 in. on a 6-in. face gear.

4. Cut out a piece from the center of the jig from the R.D. to the top or O.D. and just as long as the length of the tooth. Cut this opening straight through so that when the block for the tooth is screwed in place it will be solid while the tooth is being shaped.

5. Cut the shape of the teeth through from one end to the other (one end will be a little smaller on account of draft), thus making a jig for the shape of the tooth wanted.

6. Cut out a few more blocks than you want teeth, as you may ruin some while shaping them. These blocks should have center lines on the ends and should fit and line up with the center lines on the jig. Run one or two screws in from the back to hold the block in place while excess stock is being trimmed off with a chisel and plane.

7. Turn up any size mandrel of hardwood, at least as long as the jig; turn down in depth the thickness of the sandpaper to be used and one-fourth to one-half longer than the tooth. Cut the sandpaper to fit and glue it in. Have the ends come together but not overlap.

8. Put the mandrel in the lathe; hold the jig against this with the lathe revolving fairly slowly, and cut the tooth down until the jig and mandrel meet.

9. If the sandpaper comes flush with the face of the mandrel and is glued in securely, and the teeth are centered with the jig center lines, the teeth should be ready to glue on when the lathe work is being finished.

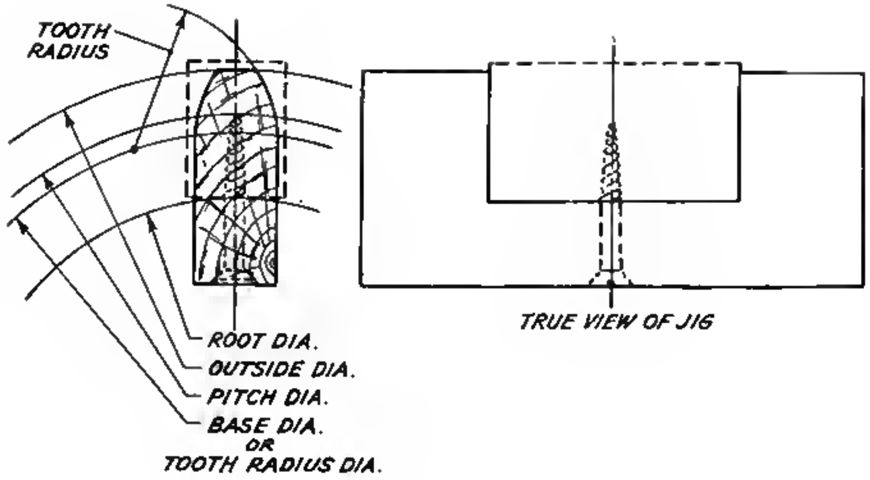


FIG. 230.

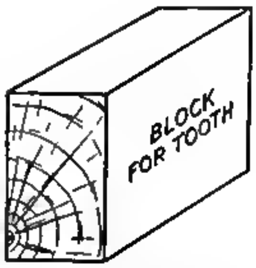


FIG. 231.

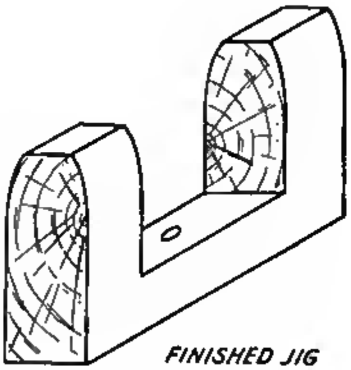


FIG. 232.

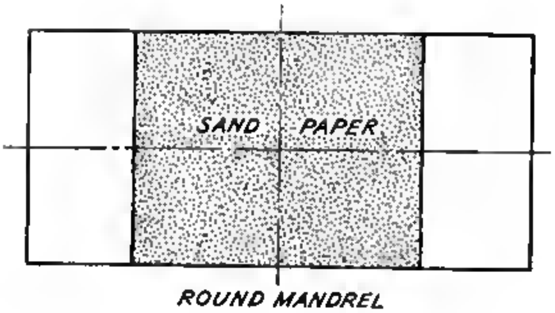
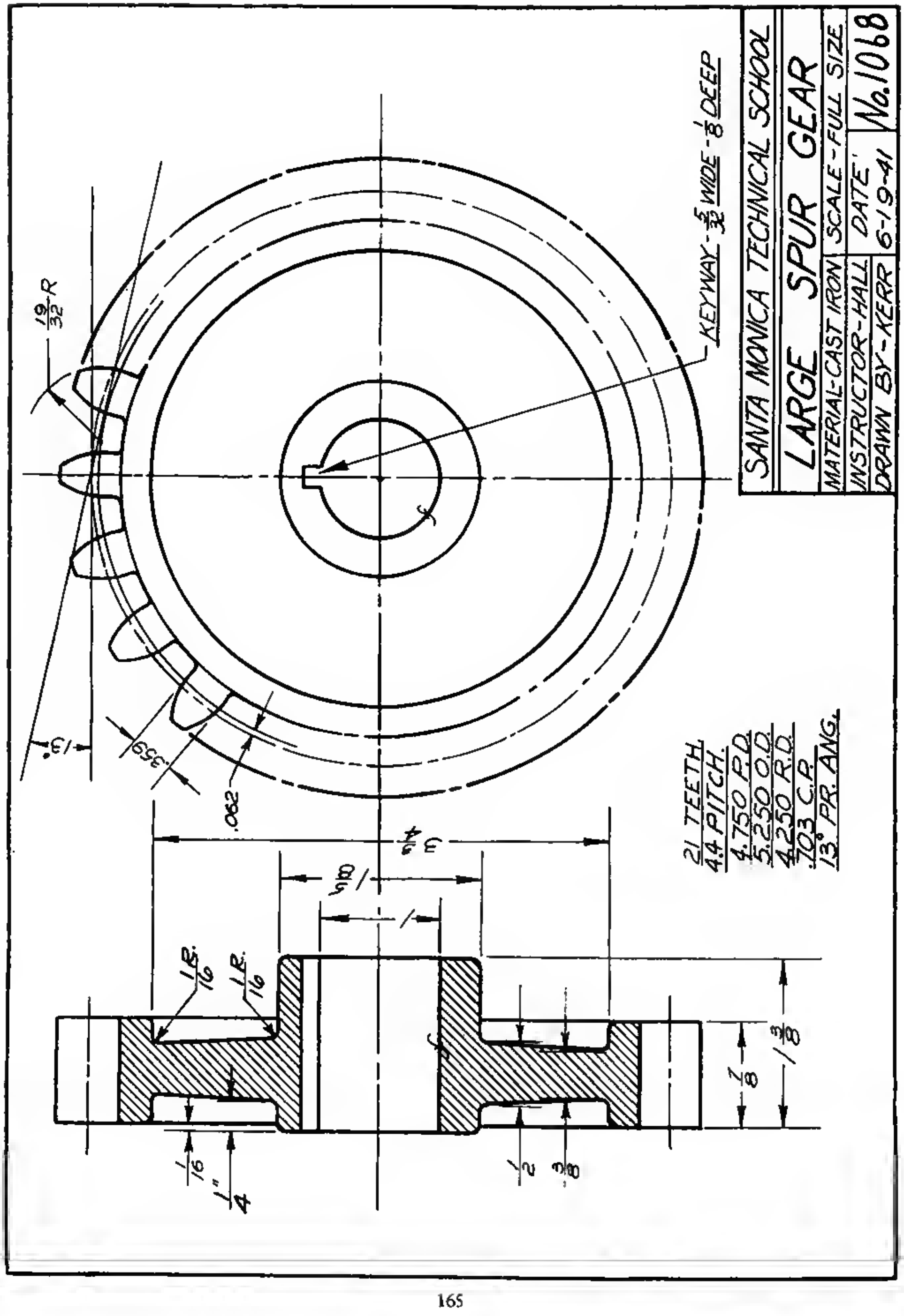


FIG. 233.

FIG. 234.


SANTA MONICA TECHNICAL SCHOOL
LARGE SPUR GEAR
MATERIAL-CAST IRON
SCALE-FULL SIZE
INSTRUCTOR-HALL
DATE'
DRAWN BY-KERR
6-19-41
No.1068
KEYWAY-5/32 WIDE-1/8 DEEP
21 TEETH.
4.4 PITCH.
4.750 P.D.
5.250 O.D.
4.250 R.D.
.703 C.P.
13° PR. ANG.
19/32 R
.359
.062
13°
1/16 R.
1 3/8
7/8
1/16
1/4"
1/2
3/8
1
f

81. HOW TO MOLD SKELETON PATTERNS

Skeleton patterns and core boxes may be constructed like the one illustrated (Figs. 235 to 238).

The pattern should be made in halves (Fig. 235), or a split pattern using dowel pins may be made. The core box should be made (Fig. 236) long enough for the core prints. A sweep (Fig. 238) should be used to strike off between the heads to make the core. Two half cores should be made and baked.

1. Lay one-half of the finished core on the bottom board, and set pattern (Fig. 235) over the core approximately at center. This makes the core prints.
2. Fill in the pattern between heads with molding sand, strike off outside of the pattern with sweep (Fig. 237). This finishes this half of the pattern.
3. Dust well and place the drag half of flask on the bottom board and ram up.
4. Turn the drag over, place second half of the finished core on top of the first half. Be sure to get it matched with bottom half.
5. Set the cope half of the pattern in place. Fill in pattern with moldin; sand and strike off.
6. Dust pattern, place cope half of flask on, and ram up.
7. Open mold, lift out cores and pattern, and clean mold.
8. Cut sprue, risers, gates, etc. Set core in place and close mold.

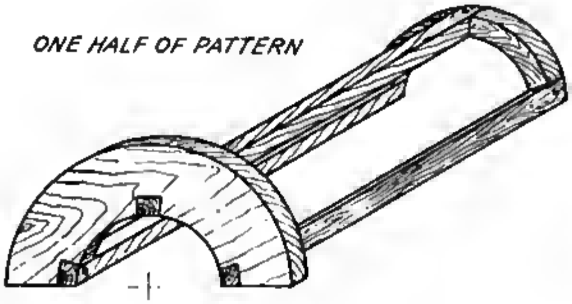


Fig. 235.

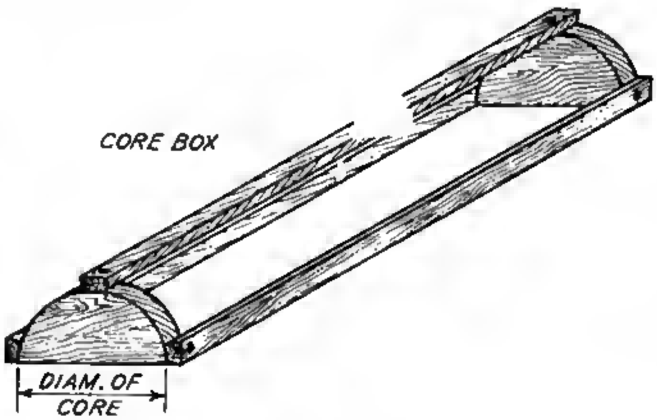


Fig. 236.

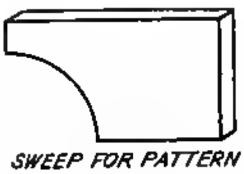


Fig. 237.

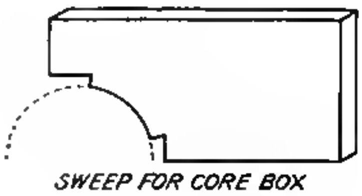


Fig. 238.

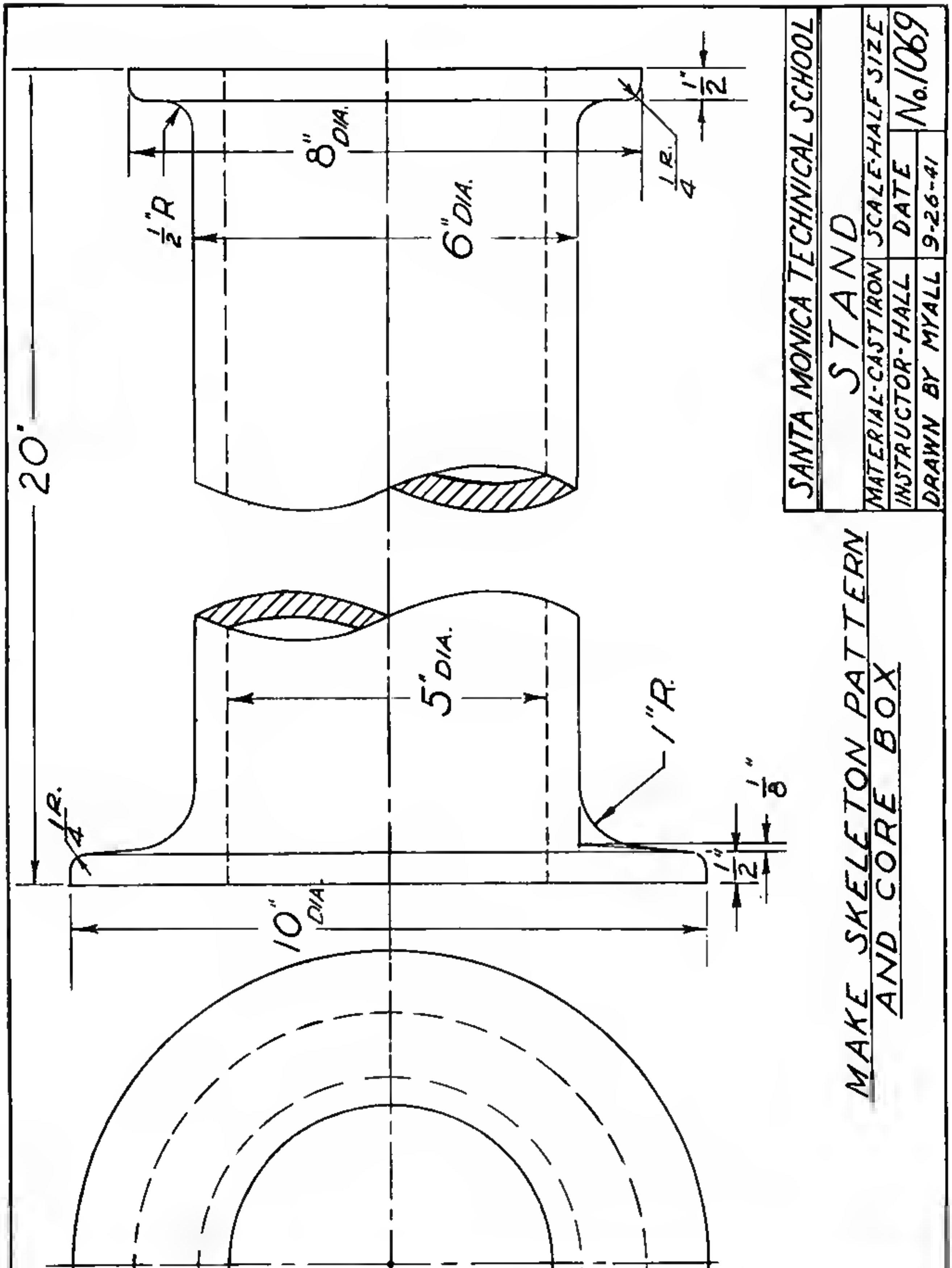
Fig. 239.—One type of skeleton pattern.

Fig. 240.—Pouring gray iron from bull ladle to hand ladle.

Fig. 241.—Pouring from hand ladle to mold in floor molding.

Fig. 242.—Pouring gray iron. Note the gas flame coming up through the center hole in the mold.

Fig. 243.—Small bench molds being poured. Note the weights in the foreground.


SANTA MONICA TECHNICAL SCHOOL
STAND
MATERIAL-CAST IRON
SCALE-HALF SIZE
INSTRUCTOR-HALL
DATE
DRAWN BY MYALL
9-26-41
No. 1069
MAKE SKELETON PATTERN AND CORE BOX
20'
8" DIA.
6" DIA.
5" DIA.
10" DIA.
1/2" R
1/4 R.
1" R.
1/2"
1/8"

82. HOW TO MAKE MEDIUM OR LARGE BEVEL-GEAR PATTERNS

If a bevel gear is too large to be cut from a solid block, the pattern should be built up and the teeth added.

1. Make a layout first to get all diameters and the shape of the teeth (Fig. 244).

2. Make a jig of hardwood much the same as for the spur gear, except taper in the teeth. Extend the lines on the layout past the ends of the teeth for stock on the end of the jig. Lay out teeth on both ends of the jig. Cut out center section. Trim from large end of teeth to small, and proceed as for spur-gear teeth.

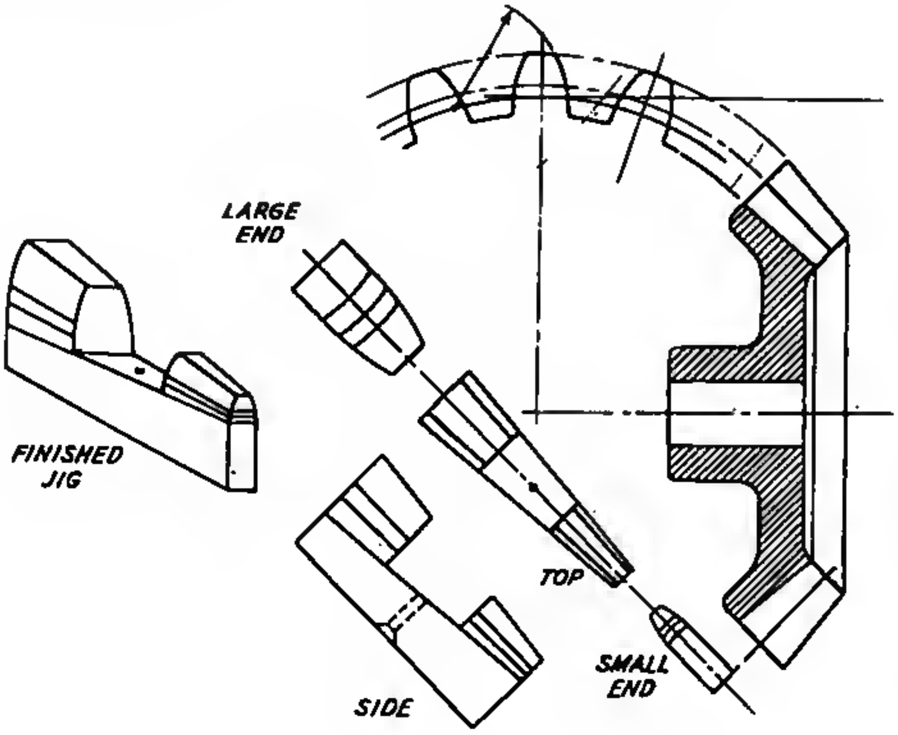
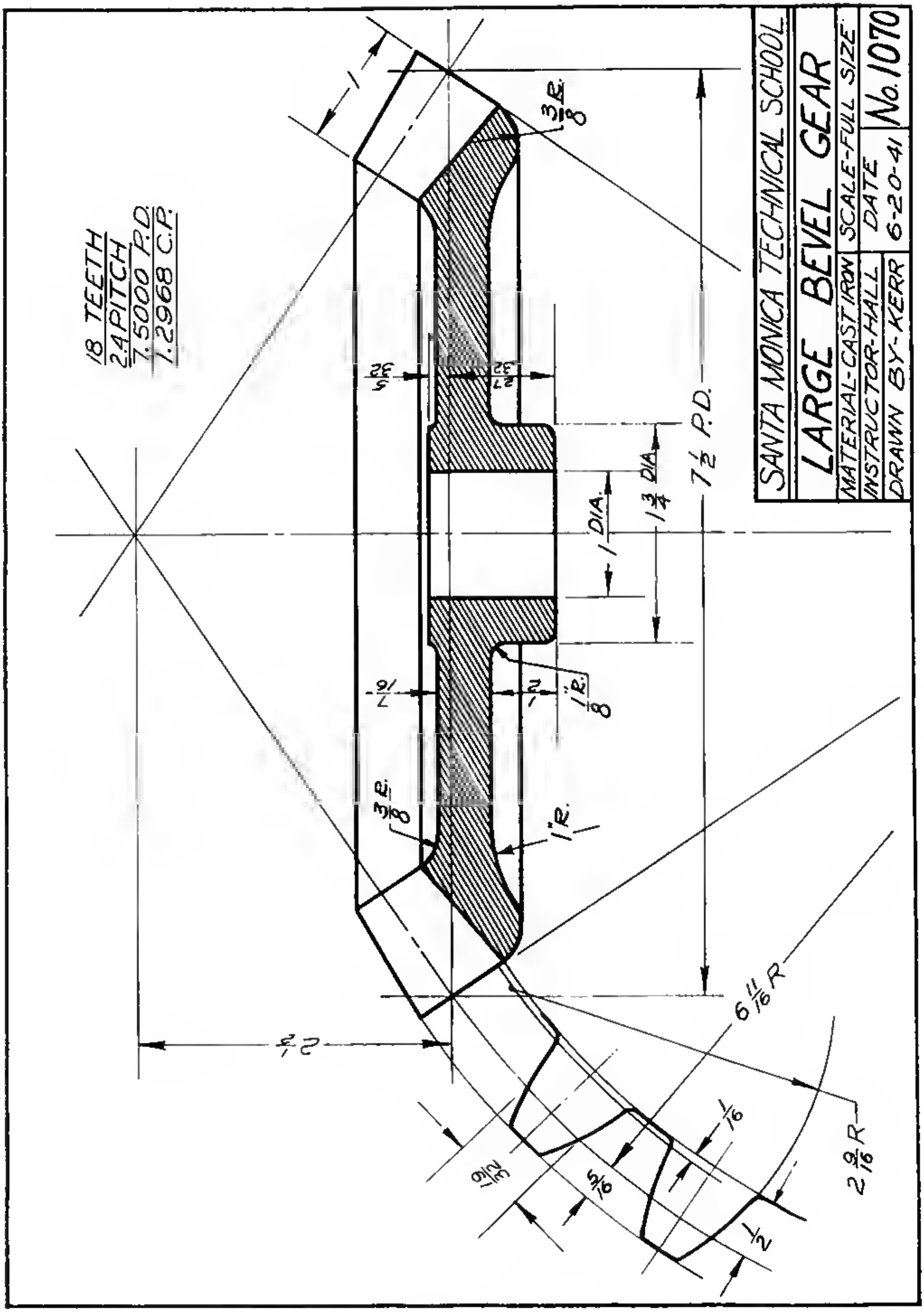


Fig. 244.


SANTA MONICA TECHNICAL SCHOOL
LARGE BEVEL GEAR
MATERIAL-CAST IRON
SCALE-FULL SIZE
INSTRUCTOR-HALL
DATE 6-20-41
DRAWN BY-KERR
No. 1070
18 TEETH
2.4 PITCH
7.5000 P.D.
7.2968 C.P.
$7\frac{1}{2}$ P.D.
$1\frac{3}{4}$ DIA.
1 DIA.
$6\frac{11}{16}$ R
$2\frac{9}{16}$ R
$\frac{3}{8}$ R.
$\frac{1}{8}$ R.
1 R.
$\frac{5}{32}$
$\frac{7}{32}$
$\frac{7}{16}$
$\frac{1}{2}$
$\frac{1}{16}$
$\frac{5}{16}$
$\frac{9}{32}$
$2\frac{1}{2}$

83. HOW TO MAKE WORM-GEAR PATTERNS

1. Turn up split pattern diameter and length with prints, if any, the size which the blueprint calls for.

Use a piece of fairly stiff paper that will just cover the surface of the pattern. The length of the paper should equal the circumference of the turned pattern; the width should equal the length of the pattern.

3. Measure up on the end the distance of the pitch of the gear or distance from center to center of teeth. Draw a straight line from this point to the same edge at the other end of the paper (Fig. 245). This angle on the paper is the pitch of the gear.

4. Lay out on the paper the width of the teeth on top, parallel to the pitch line just established. The distance of tooth centers is marked (Fig. 245). Step out centers and widths of teeth across the paper.

5. Spot paper with glue, and place it on pattern smoothly. Prick through the paper or wrap a flexible spline around the pattern following the pitch lines, and cut through into the pattern for the top of the teeth.

6. Remove paper. Lay out angle of teeth on the parting line of the pattern marked *B* (Fig. 245). Make a template (Fig. 246) with which to follow through, and cut it out.

7. Make sure whether it is right- or left-hand screw.

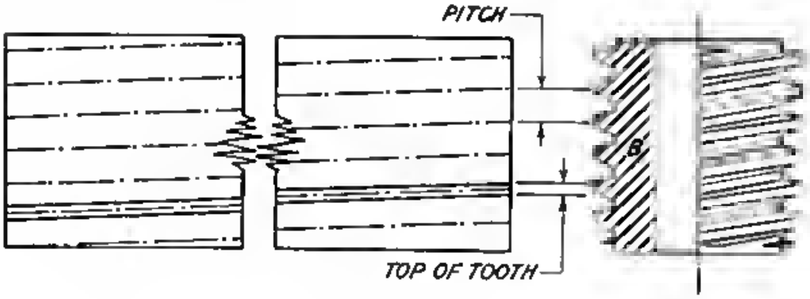
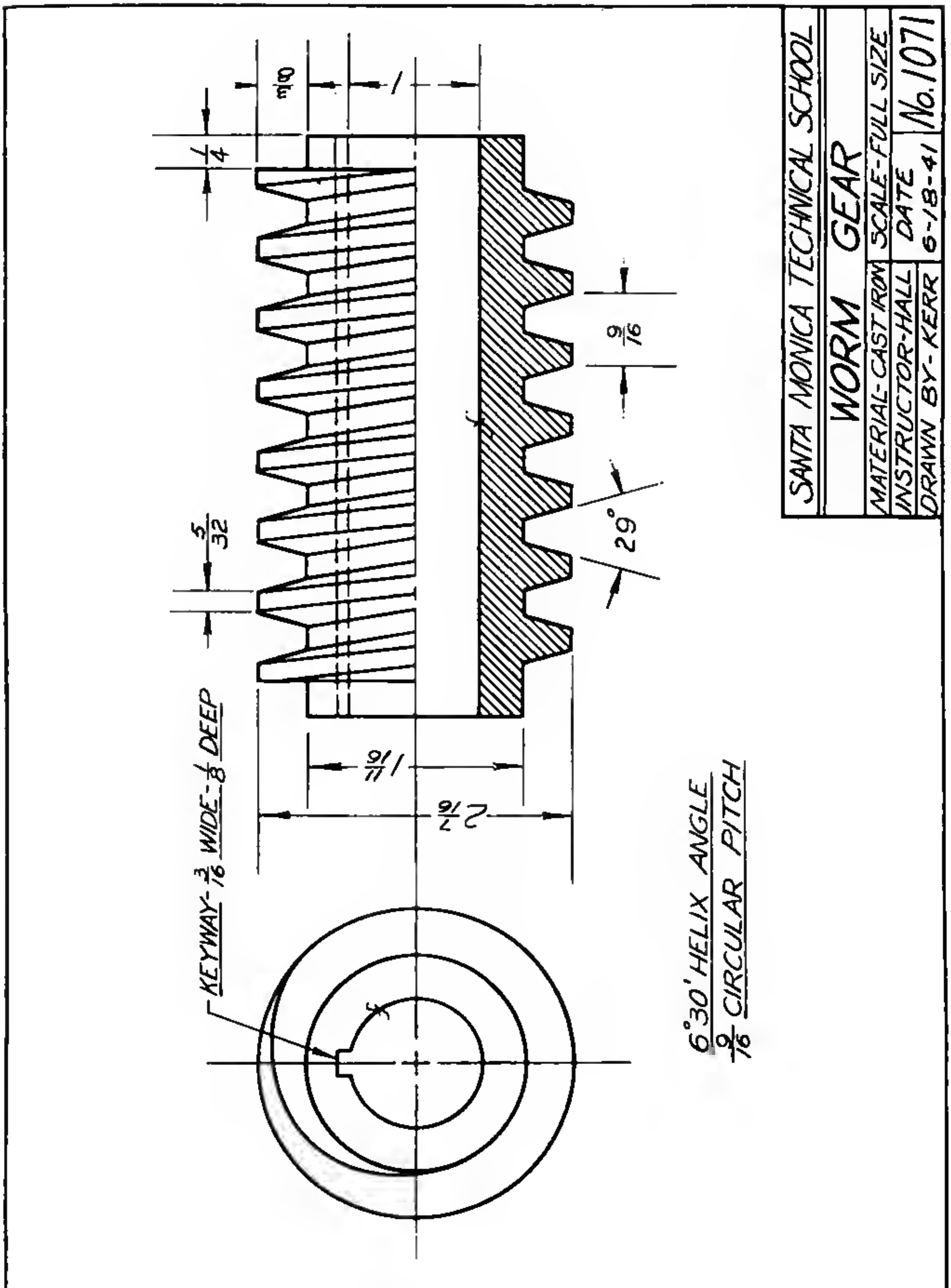
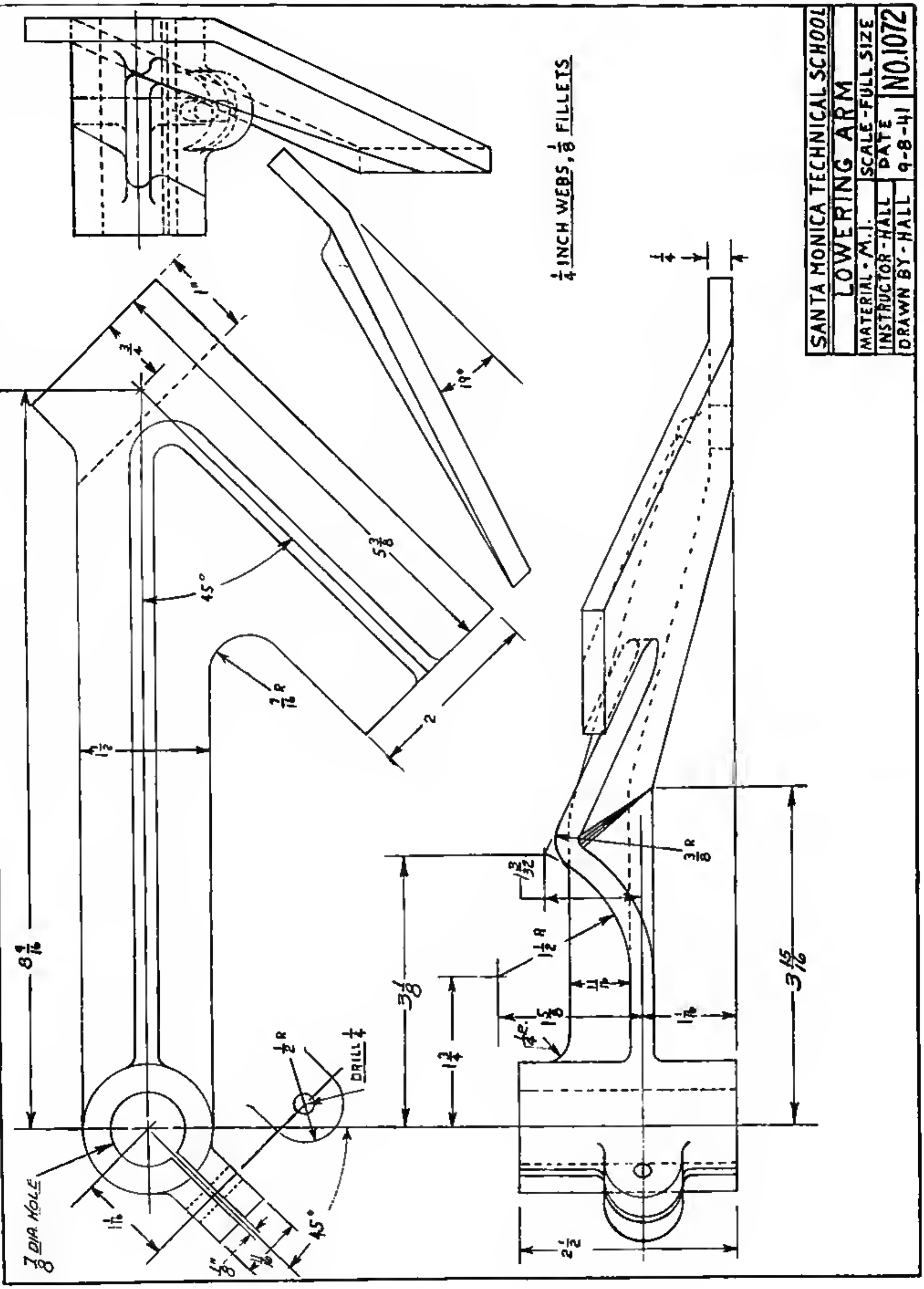
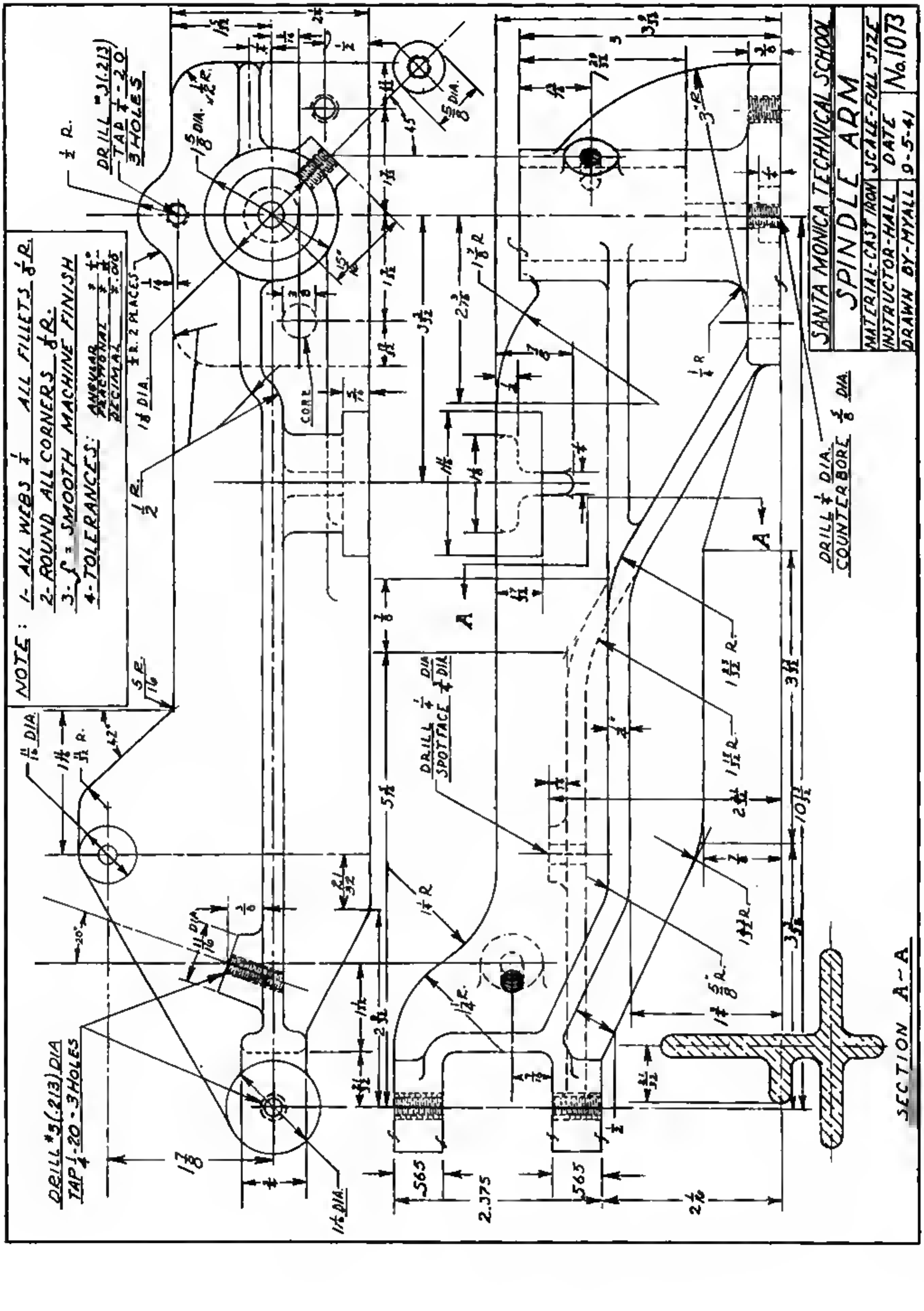


Fig. 245.

Fig. 246.


SANTA MONICA TECHNICAL SCHOOL
WORM GEAR
MATERIAL-CAST IRON
SCALE-FULL SIZE
INSTRUCTOR-HALL
DATE 6-18-41
DRAWN BY-KERR
No. 1071
KEYWAY-3/16 WIDE-1/8 DEEP
6°30' HELIX ANGLE
9/16 CIRCULAR PITCH
1/4
3/8
1
5/32
9/16
29°
1 11/16
2 7/16


SANTA MONICA TECHNICAL SCHOOL
LOWERING ARM
MATERIAL - M.I.
SCALE - FULL SIZE
INSTRUCTOR - HALL
DATE 9-8-41
DRAWN BY - HALL
NO.1072
1/4 INCH WEBS, 1/8 FILLETS
7/8 DIA HOLE
DRILL 1/4


SANTA MONICA TECHNICAL SCHOOL
SPINDLE ARM
MATERIAL-CAST IRON
SCALE-FULL SIZE
INSTRUCTOR-HALL
DATE 9-5-41
DRAWN BY-MYALL
No.1073
NOTE:
1- ALL WEBS 1/4 ALL FILLETS 1/8 R
2- ROUND ALL CORNERS 1/8 R.
3- f = SMOOTH MACHINE FINISH
4- TOLERANCES:
DRILL #3(.213) DIA
TAP 1/4-20-3 HOLES
DRILL 1/4 DIA.
COUNTERBORE 5/8 DIA
SECTION A-A

84. HOW TO MAKE A BUILT-UP FRAMEWORK FOR PATTERNS

Larger types of patterns have to be built up much the same as one would build a house. The framework is first built up, and then the outside is put on. A layout should be made first of the outside dimensions of the pattern to be built. The thickness of the stock to be used on the outside of the framework is marked off on the layout. Frames should be built strong and accurate.

One may have to make two or a dozen frames (Fig. 247) for a pattern, depending upon the size and shape of the job. To make a number of the same type, strips of wood are nailed on the layout board making a jig, and all frames will then be the same.

A halved or lapped joint (Fig. 248) is stronger, as it is better braced, but it is also more difficult to make.

Naturally, different-shaped patterns will have different-shaped frames, but the method is the same even though the shapes are odd and built up of many pieces (Fig. 250). The frames are joined by a piece of stock running through the corners and sometimes the sides, or maybe both. The number of these pieces would be determined by the size of the pattern. After the frames have been joined and well braced, the sides, top, base, etc., are added (Fig. 249).

The larger the job, the more responsibility to the patternmaker, as a mistake in such work may cost many dollars in labor and material. Every dimension should be checked on the layout, and one should try to visualize the shape of the pattern, and just how he is going to make the pattern, before starting work.

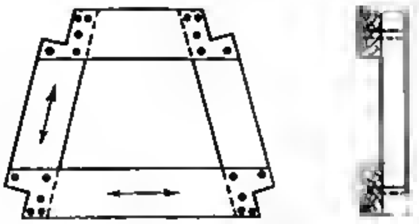


Fig. 247.

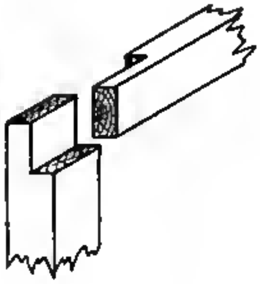


Fig. 248.

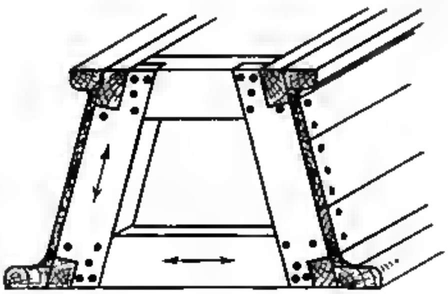


Fig. 249.

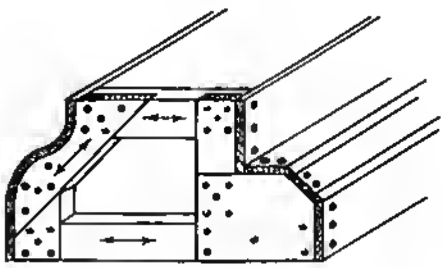


Fig. 250.

85. HOW TO USE A CUPOLA AND CRUCIBLE IN METAL MELTING

Cupolas are usually used for the melting of all irons. These are tall 25- to 50-ft. steel furnaces lined with fire clay and brick. A door, called the *charging door*, is high above the foundry floor. This is where the fuel and iron are put in. Cupolas vary in size. A 30-in. cupola has a capacity of about 3 to 4 tons an hour, while a 72-in. cupola is capable of melting 18 to 25 tons per hour.

Coke is the common fuel used. Wood is placed on the hearth or bottom of the cupola with coke on top. Gas is commonly used to ignite this. Iron and coke are placed in layers through the charging door from the second floor. Air from a blower is forced through the bottom of the cupola, acting like a giant blow torch, creating intense heat which is necessary to melt the iron. This melting process takes less than 30 min. after the air is turned on.

After the iron is melted, it is run out through a small opening near the bottom of the cupola into various-sized ladles. These ladles are carried by crane or hand, and the iron is poured into individual molds on the foundry floor. After the iron has cooled sufficiently, the molds are turned or dumped and the castings racked out. The gates are broken off, and the castings are then put in a tumbling mill which rattles the sand off.

Crucible furnaces are used in foundries where a small quantity of metal is to be melted at one time. Aluminum, brass, bronze, copper, lead, zinc, etc., are usually heated in this way. Most foundries have their crucibles in pits so the tops are set nearly flush with the floor. The pots are set in and taken out with tongs and placed in a holder and carried to the mold and poured. Many sizes and types of crucibles are manufactured. Some are heated with gas, oil, or electricity. They range in size from 25 to 1000 lb. capacity. (See Figs. 251 to 253).

TABLE OF WEIGHTS AND MELTING POINTS OF METALS

Metal	Weight per cubic foot	Weight per cubic inch	Approx. melting point, degrees Fahrenheit
Aluminum	166.5	0.0963	1215
Antimony	421.6	0.2439	1166
Barium	......	......	1562
Bismuth	612.4	0.3544	516
Brass	536.3	0.3103	1800
Bronze	552.	0.3195	1900
Cadmium	539.	0.3121	600
Calcium	98.5	0.0570	1436
Chromium	311.8	0.1804	2759
Cobalt	533.1	0.3085	2727
Gold, pure	1,200.9	0.6949	1915
Copper	552.	0.3195	1980
Iridium	1,396.	0.8076	3960
Iron, cast white	450.	0.2604	1975
Iron, cast gray	450.	0.2604	2192
Iron, wrought	480.	0.2779	3000
Lead	709.7	0.4106	625
Magnesium	109.	0.0641	1200
Manganese	499.	0.2887	2273
Mercury	846.8	0.4911	39
Nickel	548.7	0.3175	2804
Palladium	......	......	2820
Platinum	1,347.0	0.7759	3236
Potassium	53.9	0.0312	143
Silver	655.1	0.3791	1750
Sodium	60.5	0.0350	206
Steel	489.6	0.2834	2507
Tantalum	......	......	5162
Tin	458.3	0.2652	442
Titanium	330.5	0.1913	3362
Tungsten	1,078.	0.6243	5792
Zinc	436.5	0.2526	780

General Information on Making Alloys

Alloy	Elements	Per cent	Alloy	Elements	Per cent
Gray iron (cast iron)...	Iron	93.00	Bronze................	Copper	90.00
	Carbon	3.25		Tin	10.00
	Silicon	2.50	Red brass.............	Copper	85.00
	Manganese	0.50		Tin	5.00
	Phosphorus	0.65		Lead	5.00
	Sulphur	0.10		Zinc	5.00
Malleable iron.........	Iron	96.70	Yellow brass...........	Copper	73.00
	Carbon	1.50		Tin	23.00
	Silicon	1.00		Lead	2.00
	Manganese	0.40		Zinc	2.00
	Phosphorus	0.30	Aluminum............	Aluminum	92.00
	Sulphur	0.10		Copper	8.00
Common steel.........	Iron	99.00	Dowmetal.............	Magnesium	91.06
	Carbon	0.47		Aluminum	8.00
	Silicon	0.05		Manganese	0.04
	Manganese	0.40			
	Phosphorus	0.03			
	Sulphur	0.05			

Fig. 251.—Large cupola for melting gray iron. Note the blower pipe coming in at the back.

Fig. 252.—Metal running from cupola to bull ladle.

Fig. 253.—Crucible melting aluminum. Tongs are used for lifting pot.

86. TERMS USED IN AIRCRAFT SHEET-METAL WORK

Figure 254 is an angle (formed 90 deg.).

Figure 255 is an open angle (formed less than 90 deg.).

Figure 256 is a closed angle (formed more than 90 deg.).

Figure 257 is a channel.

In the above-mentioned illustrations, -1 is read as "dash one," -2 is read as "dash two," etc.

Leg.—The longer part of an angle (see -1).

Flange.—The shorter part of an angle. If each part is the same length, each is known as a leg (see -2).

Thickness (represented by the letter T).—Thickness of sheet metal (see -3).

Mold line (ML).—The intersection of the extended lines from the outside of the leg and flange (see -4).

Mold-line measurement.—Any measurement to the mold line (see -5).

Bend line (BL).—The point where the metal starts to bend (see -6).

Bend-line measurement.—A measurement to the bend line (see -7).

Bend allowance (BA).—The amount of material necessary for the desired bend, or the amount of material between bend lines (see -8).

Radius (R).—Always on the inside of the metal unless otherwise stated (see -9).

Web.—On a channel, the leg becomes the web (see -10).

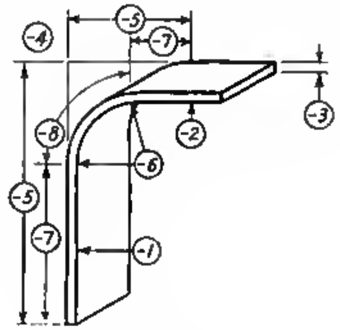


Fig. 254.

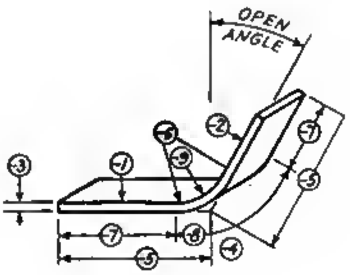


Fig. 255.

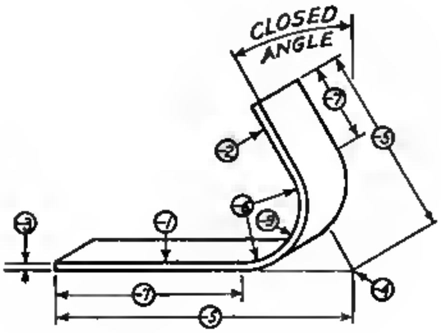


Fig. 256.

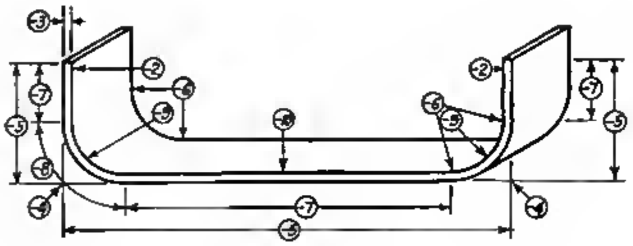


Fig. 257.

87. HOW TO MAKE FORM BLOCKS

In aircraft factories a patternmaker is occasionally required to make form blocks. To make them, it is necessary to understand something about sheet metal and aircraft parts.

Hardwood Form Blocks.—Form blocks are made of hardwood, masonite, aluminum, zinc, or steel. They are carefully and accurately made to a predetermined size and shape. They are used mostly in a hydraulic press as a shape over which sheet metal is formed, in much the same manner as a hat is shaped over a hat block. The block is placed in the press with a flat piece of sheet metal held in position by dowel pins. When the press is closed, a thick rubber pad in the upper part of the press is forced down over the sheet metal and the block with a pressure of 500 to 1000 lb. per square inch. This pressure causes the rubber to flow around the block and carries the metal with it, thus making the metal shape itself to the block.

Form blocks are made from templates. Templates are made of sheet steel or aluminum alloy that is painted on one side. They are very accurately made and should be used carefully. A template should not be used as a drill jig. If one drills through the pilot holes in a template, in a short time the holes lose their accuracy because the drill cuts away the sides of the hole. However, in some shops it is permitted to drill through a pilot hole in a template, using the twist drill in an egg-beater-style hand drill. The use of a duplicating punch to locate a hole is much to be preferred. One should not clamp a template to the block material and file to the template or he is likely to wear away the template. Always scribe around the template and file to the scribed line. Templates should be used with the painted side up unless otherwise noted.

Form-block Template.—The most common type of templates used in form-block making are the form-block template marked FBT, the mold-line template marked MLT, and the contour template marked CT. The form-block template is one that is the exact size and shape of the form block.

On the painted side is stamped the following information: part number, model number, change if any, thickness of block (at least $\frac{1}{8}$ in. deeper than longest flange), the directions of flanges, bend radii, bevels—whether open or closed—degree of bevel, type and size of lightening holes, additional block material required (open bevel only), pinholes and the size necessary if over No. 40 drill, joggles, direction of flanges of lightening holes.

Mold-line Template.—A mold-line template is the exact size and shape of the finished part; that is, it is the same as the form-block template except that it has the thickness of the sheet metal added on sides that have flanges.

This template has the following information stamped on it: dash number, latest change letter, type of template, model number, lightening holes if any, degree of bevels, station number, joggles, longeron locations.

Contour Template.—A contour template is a template whose edge has the exact curvature of the mold line of a part at a definite point.

In making a block using a form-block template, the best method is to clamp the template on the block of material it is to be made of and locate the pinholes, tooling holes, or lightening holes. Then install dowel pins and replace the template on the block with the pins installed. Scribe around the template to get the proper shape of the block. Watch very closely and be

sure about the edges of the block, whether 90-deg., open, or closed bevel. Take into consideration the spring back, as the pressure is released by the press. Metals will spring back 4 to 10 deg., depending upon the thickness and hardness of the metal. This spring back is taken care of on the form block by making it 4 to 10 deg. more than the finished part should be. Saw and file—or if made in wood, use spokeshave and sander—to the scribed line. Make bend radii on sides that have flanges.

Blocks from a Mold-line Template.—A block may be made from a mold-line template in the same manner except that the thickness of the stock must be subtracted from the sides that have flanges.

Blocks often have to be made with a certain shape and size cavity in them. In making these blocks it is convenient to use a contour template or several contour templates that will give the exact shape at several points. After the cavity is shaped to the templates at the several points, the patternmaker will have to "fair" in a smooth curve between the points. When making a block of this type it is generally necessary to make a "trim line" on the block. This line designates where the part shall be trimmed. To get this line it is convenient to use an "apply-trim templatc," or ATT, if that is available.

Duplicating Punch.—A duplicating punch is a tool that is not generally found in a patternmaker's tool chest. This punch is one with parallel sidcs and with a short conical point similar to a pin punch. It comes in various sizes, the most frequently used being No. 40 and No. 10. They are used through holes in templates to locate the centers of those holes on some other material.

Lightening Holes.—A lightening hole is put into aircraft sheet-metal parts for two reasons: (1) to lighten the part by removing metal that is not needed there; (2) to stiffen the part by means of the flange around the hole.

In form-block work cavities for lightening holes may be made two ways: (1) by means of a formed end mill; (2) by means of formed bits on fly cutters. In each case a pilot hole must be drilled, generally 1/4 in. in diameter. For lightening holes that are other than circular in shape, special ground router bits are used. The standard lightening hole has a plain 60-deg. flange (Fig. 258). There are two other less commonly used types of lightening holes that have a different flange. One has in addition to a 60-deg. flange a flange parallel to the web of the part (Fig. 259). The other has practically no flange at all but has a raised or beaded section around the circumference of the hole (Fig. 260).

All aircraft companies use one or more of these types. When first starting to make form blocks for a new company, one should check with his foreman to ascertain just what type to use. In many cases the print will give a drawing number which will give the company's standard dimension for that type of lightening hole.

Joggles.—A joggle is a depression in a part to permit the overlapping of another part and still present a smooth surface for a third part (Fig. 261). Joggles are dimensioned for depth and length on the blueprint. The length is generally given as a distance parallel with the mold line from the uppermost surface to the bottom of a joggle. It should be three times the depth of the joggle.

Check Jigs.—A patternmaker in the aircraft industry is frequently called upon to make what is known as a *check jig*. Sections of airplane skins are often fitted to these jigs during the process of fabrication in order to ascertain that the part is taking the proper shape; that is, portions of the skin that have compound curvatures are fitted to the jig, using the jig as a gage. In making a check jig, the loft department generally supplies contour templates at specified stations along that portion of the ship that is to be covered by that particular piece of skin. The

patternmaker's job is to make wood formers having the same contours as the templates and space the formers the proper distance apart with separators whose top surfaces are tangent to the contoured edge of the formers so as to make a skeleton jig having the proper shape. Figure 263 shows a typical jig.

Check Blocks.—A check block is similar to a check jig except that it is made solid and is usually smaller.

Fig. 258.

Fig. 259.

Fig. 260.

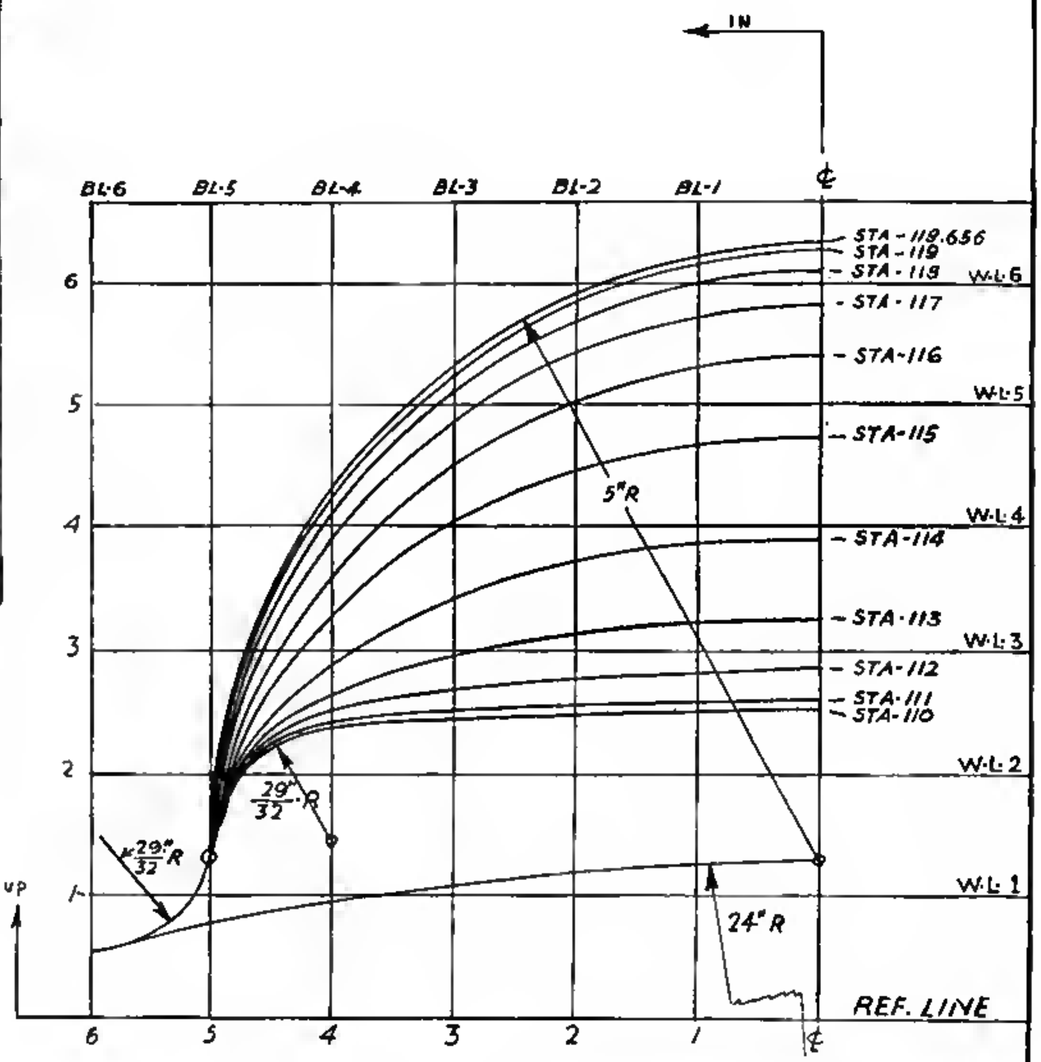
Fig. 261.

DIMENSIONS GIVEN IN INCHES AND 32NDS

	STA 110	STA 111	STA 112	STA 113	STA 114	STA 115	STA 116	STA 117	STA 118	STA 119	STA 119.656
DISTANCE ABOVE											
℄	2-16	2-19	2-27	3-8	3-29	4-24	5-12	5-26	6-3	6-8	6-10
BL-1	2-16	2-19	2-26	3-7	3-28	4-22	5-10	5-23	6-0	6-5	6-6
BL-2	2-15	2-18	2-25	3-5	3-23	4-15	5-1	5-14	5-22	5-27	6-28
BL-3	2-14	2-17	2-22	2-31	3-14	4-2	4-17	4-28	5-4	5-8	5-9
BL-4	2-12	2-13	2-16	2-21	2-28	3-10	3-20	3-29	4-4	4-8	4-9
BL-5	1-10	1-10	1-10	1-10	1-10	1-10	1-10	1-10	1-10	1-10	1-10
BL-6	0-17	0-17	0-17	0-17	0-17	0-17	0-17	0-17	0-17	0-17	0-17
HALF BREADTHS											
WL-1	5-4	5-4	5-4	5-4	5-4	5-4	5-4	5-4	5-4	5-4	5-4
WL-2	4-24	4-24	4-25	4-25	4-26	4-27	4-28	4-29	4-30	4-31	4-31
WL-3				2-28	3-27	4-9	4-14	4-19	4-21	4-23	4-23
WL-4						3-4	3-21	3-31	4-4	4-6	4-7
WL-5							2-4	2-28	3-6	3-10	3-12
WL-6									1-1	1-19	1-23

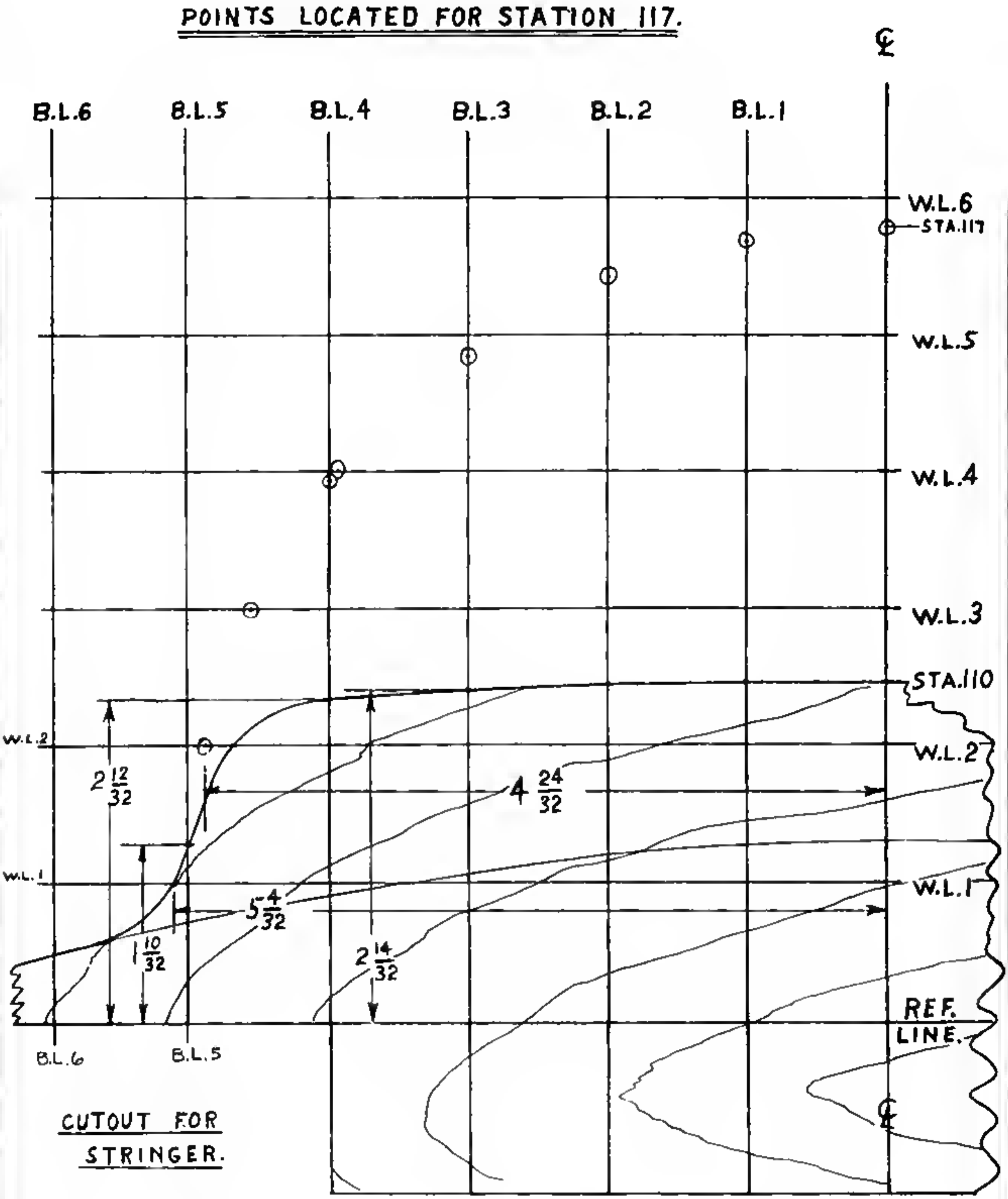
LEGEND:

Reference Line —— Ref.
Distance Above —— Above Ref. Line
Buttock Lines —— B.L.
Water Lines —— W.L.



.064 MATERIAL

SANTA MONICA TECHNICAL SCHOOL		
CHECK JIG FOR OIL COOLER		
MATERIAL - PINE	SCALE - FULL SIZE	
INSTRUCTOR - HALL	DATE	Nº
DRAWN BY - HALL	9-9-41	1074



LAYOUT OF STATION #110 ON BLUEPRINT No 1074.

9-9-41. HALL.

88. HOW TO USE CHECK JIG, BLUEPRINT 1074

When making check jigs, jigs, or dies and some of the larger patterns in the aircraft and ship industry, the patternmaker often works from stations. These stations start at 0 and run back from the front of the ship. The station 0 may start from the nose of the ship or it may be from the fire wall. In a wing section, station 0 would start from the center line of the ship and number out toward the wing tip. The 0 station or starting point is always shown on the assembly drawing.

The check jig shown (Fig. 263) is started at station 110 and numbered back to 120. This would indicate that station 110 is 110 in. back from the nose of the ship, and the jig should be the shape shown at this station. Station 111 will have a little different shape from 110, and 112 still different, etc. When the stations are all laid out and cut to the lines, they are set up on two stringers or strips of wood as a base to support them. These stringers are marked off in inches from 110 to 119. The stations are glued and nailed on the stringers, and then the different stations are faired in from one station to another; this would mean trimming the one edge off each station accurately (Fig. 264) to make a nice contour over the face of the jig.

Buttock lines are the lines running from the base or reference line to the top of the station. ℄ would be the center line (buttock line marked Bl.) Bl. 1 is 1 in. from the center line, Bl. 2 is 2 in. from the center line, etc. So this jig should be 6 in. from the center line each way or 12 in. wide and 9 in. long.

Now to lay out station 110 the stock should be approximately $\frac{1}{2}$ in. thick, 5 in. wide, and 14 in. long. All Bl. lines should be marked in 1 in. apart and the reference line gaged in. The center line on the chart, in the upper left-hand corner, shows that this point should be $2\frac{16}{32}$, or $2\frac{1}{2}$, in. above the reference line. Bl. 1 would be the same height, $2\frac{1}{2}$ in. Bl. 2 is $2\frac{15}{32}$. Bl. 3 is $2\frac{14}{32}$. Bl. 4 is $2\frac{13}{32}$, etc. When all these points are found, a spline, or flexible wood or metal strip, should be used to fair in from one point to another.

All the other stations are made the same, only according to dimensions. One should start at the top of the chart on the station wanted and follow down to the bottom. There will be 11 different stations to set up.

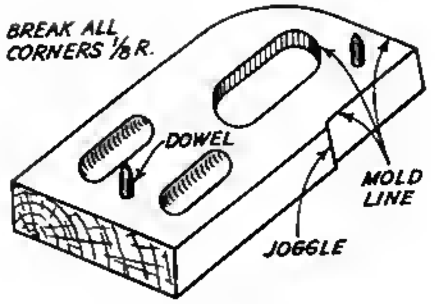


Fig. 262.

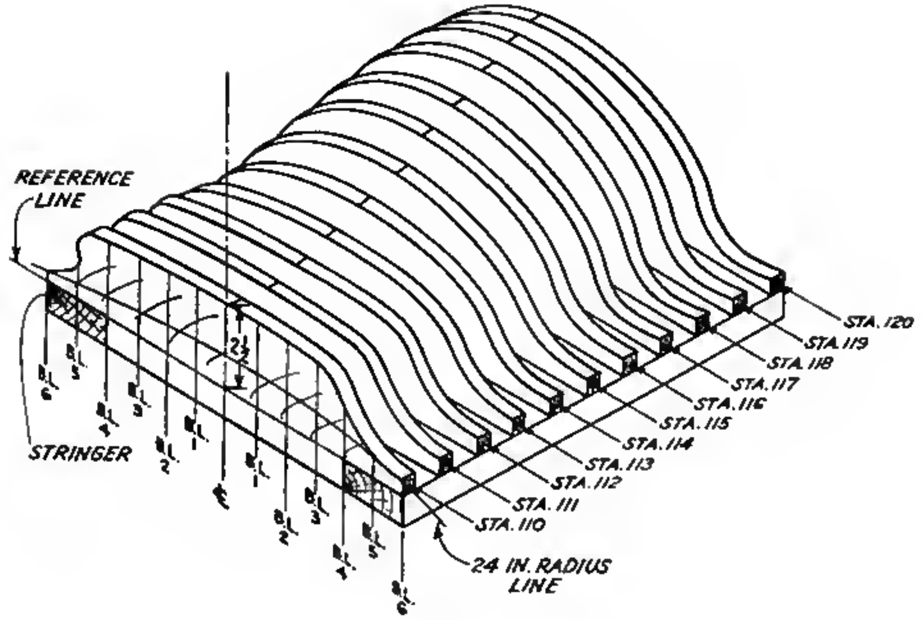


Fig. 263.

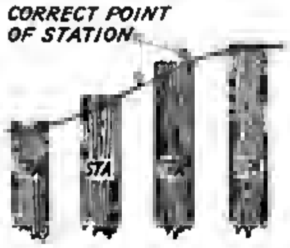


Fig. 264.

89. PATTERN-SHOP NOTES

Sandpaper can be cemented to the disc sander with waterglass.

Wood fillets can be purchased in sizes from 1/4 to 2 in. radius.

Flasks are made in about 60 sizes, from 12 by 12 to 30 by 40 in.

Shellac is thinned with alcohol or solvent.

Metal letters may be fastened to patterns with shellac or lacquer.

An 8-in. table saw should run 4500 r.p.m.; a 10-in., 3600; a 12-in., 3000.

For screw lubricant, use soap, beeswax, or paraffin.

When etching or marking tools, use 3 parts nitric acid to 1 part muriatic acid.

A quire of sandpaper is 24 sheets; a ream is 20 quires, or 480 sheets.

Crucibles are made of graphite and clay.

Graphite or plumbago is used in dusting molds to make smooth castings.

Lemon juice will remove mahogany stains from your hands.

When nails are to be used in molding, it is best to have rusty ones so they will stick in the sand.

To clean the glue pot, put cold water in it and allow it to soak overnight.

Use paraffin on bottom of plane to make it slide easily.

Grind drill about 59 deg. for best results in cast iron and steel.

The router for pattern work should run 25,000 to 30,000 r.p.m.

Wet the sand in the foundry at night for use in the morning.

To make stick shellac, place flake shellac in a cloth bag, dip into hot water, then take out and form.

The size of a gear is always the pitch diameter.

Standard draft on drop forging dies is 7 deg.

One-degree draft is 7/32 in. to the foot.

One inch is 2.54 centimeters, or 25.4 millimeters. One foot is 0.3048 meter.

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